A Guide to Oyster-farming

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FOREWORD

British Columbia has developed a small but well-organized oyster industry. It began as a fishery for the small native oyster, which declined in abundance with overfishing. Culturing of the native oyster began only shortly before it disappeared from markets here. This decline necessitated the introduction of the Japanese (Pacific) oyster, and the initial annual importation of seed resulted in a relatively high level of culture from the beginning.

With the precipitous nature of the coastline, British Columbia is not well endowed with large areas of flat, firm, foreshore bottom characteristic of countries with extensive oyster industries. However, it is possible with the Pacific oyster to fit suitable and effective methods of culture to the varied geographic features of the Province.

The productive potential is therefore considerable, but at present the limiting factor is market demand. The average annual Canadian consumption of oysters is only about one-tenth of a pound per person. Raising this amount to only 1 pound per person would increase tenfold the production requirements. Thus, given a market, which in fact is there to be developed, there is ample opportunity for expansion, not only by the present growers but for newcomers to the industry.

Growing oysters involves some physical effort, for the possibilities of automation are limited; however, there is a good deal of satisfaction to be derived from working with a living organism in a natural and, of necessity, pure environment usually remote from urbanization.

Varied technologies of oyster production have been developed for British Columbia conditions and it is the purpose of this report to detail some of these and to outline the administrative requirements. This information may be further supplemented by more comprehensive publications that are available and by advice from the Marine Resources Branch.

INTRODUCTION

Oyster-farming or oyster culture, as it is commonly known, has attracted considerable interest in recent years in British Columbia. This handbook was prepared to provide a guide to prospective oyster-growers and small growers who wish to increase their present production, and to provide a source of information to the general public. Information provided in this publication was derived from research conducted by Dr. D. B. Quayle of the Fisheries Research Board, the Marine Resources Branch, and from oyster-culture methods practised by the oyster industry.

If the reader requires more information on the subject, a list of comprehensive publications is printed in the back of this handbook.

BIOLOGY

Life History

In the Japanese oyster the sexes are separate, that is, there are male and female oysters, although the sex may change from year to year. Japanese oysters begin to develop the sexual products in the spring when water temperatures begin to rise, and under normal temperature conditions in most British Columbia waters they are fully ripe by the end of June or the middle of July at the latest. Sex of oysters cannot be determined, except by examination of the reproductive tissue. The veined gonad covers both sides of the body. In the spawning act oysters discharge the sexual products into surrounding waters where fertilization takes place.

FIG. I. Spawn of Pacific oysters.

Very soon the young oyster or larva is able to swim and rapidly develops two fragile shells. Its ability to swim is limited to keeping itself in the upper layers of water, where it is at the mercy of currents. Within a few days the young animal has developed a number of essential organs, such as a digestive system and velum, which is the specialized mechanism for swimming and gathering food.

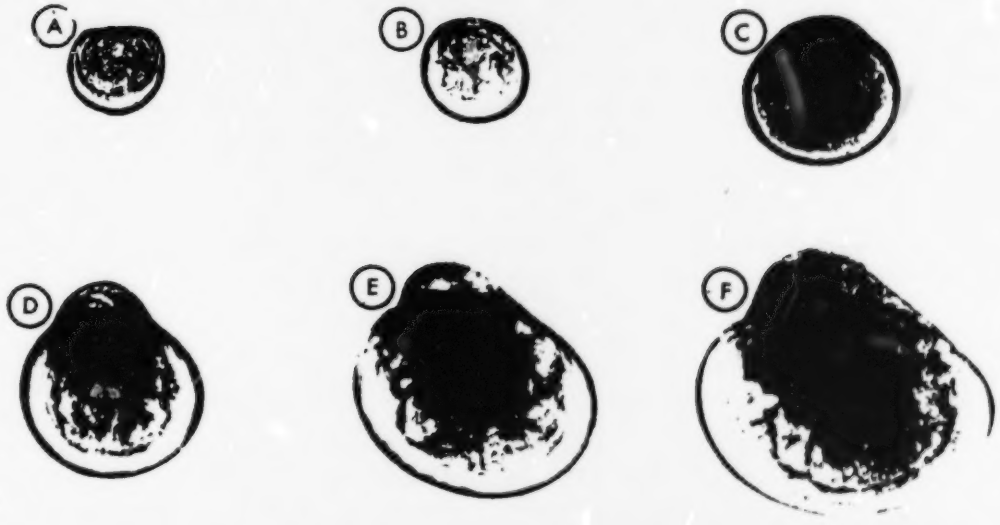

FIG. II. Stages of larval development of the Pacific oyster X 117. A=Straight hinge stage (90 μ); B=Very early umbone (110 μ); C=Early umbone (160 μ); D=Midumbone (200 μ); E=Late umbone (250 μ); F=Advanced umbone (300 μ).

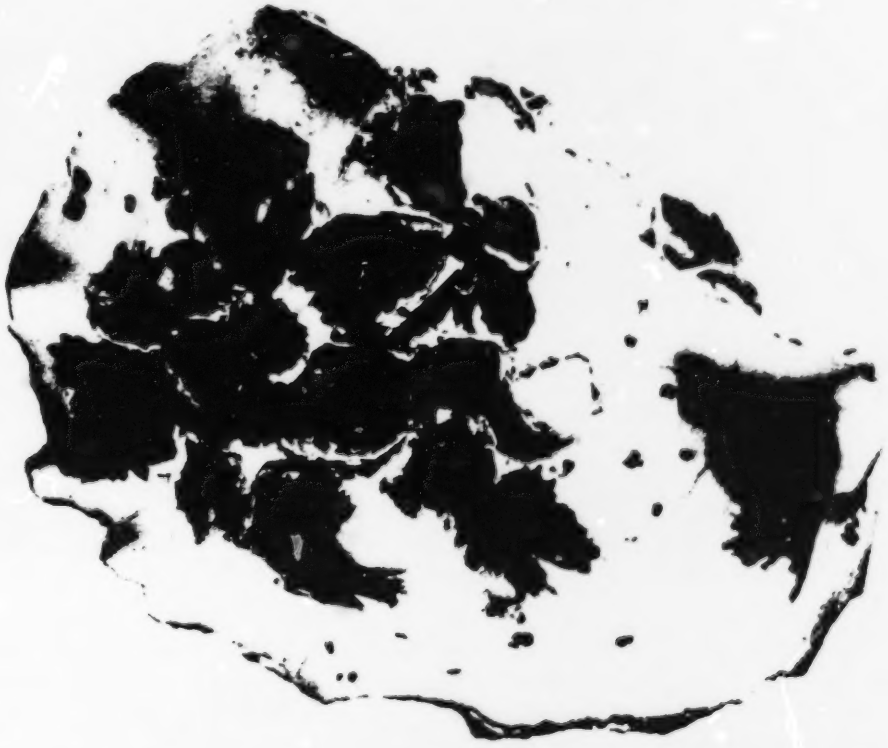

FIG. III. Oyster shell with oyster spat about one-half inch in diameter at two months X 0.7.

As the larva grows, more and more organs are developed, until at the end of 17 to 20 days it has most organs of the adult oyster and, indeed, some that the adult does not have—for instance, a foot similar to that found in a clam and two adductor muscles which hold the shells together (the adult oyster has only one). At this time the Pacific oyster larva is approximately one eightieth of an inch in length and it is ready to become attached. In the course of being swept along by currents, larvæ may strike a solid object, such as shells of older oysters. Material on which oyster larvæ settle is called "cultch." When the young oyster finds a suitable spot it squeezes from a gland in the foot a tiny pool of cement into which is inserted the left valve of the larva. The cement sets rapidly and the young oyster is now immobile and remains so for the remainder of its life. At this point the foot and one of the two adductor muscles are lost. This process of becoming cemented to some solid object is called "setting" or "spatting," and the young oyster is called a "spat" or a "seed."

If food and temperature conditions are suitable, growth is rapid and oysters spatted early in summer may be as large as a 25-cent piece when growth slows down with the advent of lower water temperatures in the fall. Sexual maturity comes early in Japanese oysters, although it is a function of size rather than age, and if the young oyster is large enough it may spawn in the first summer after spatting.

Anatomy

It is necessary for an oyster-grower to be familiar with at least the larger and more prominent anatomical features of an oyster. The shell of the oyster consists of two valves, a larger, lower, and usually cupped left valve, and a smaller, upper, fairly flat right valve. The two valves are hinged at the anterior, which is usually pointed and termed the umbonal end. The hinge, which is internal, tends to spring the valves apart. It is opposed doing so by a single adductor muscle which is attached to each valve about two thirds the distance from the umbones.

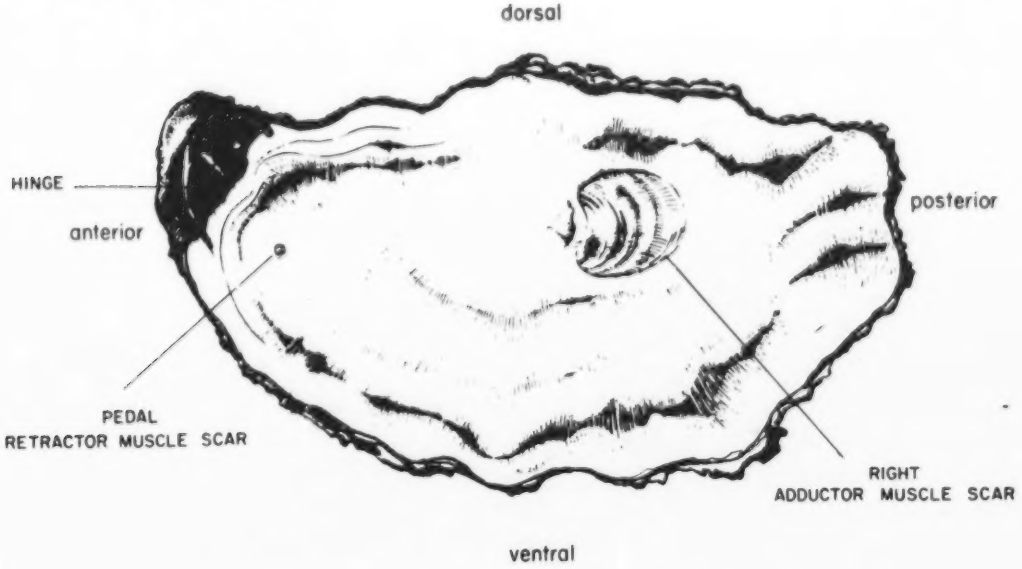

FIG. IV. Internal view of right valve of a Pacific oyster.

The shell itself is composed of three layers. The inner is a thin, hard, and usually shiny layer called nacre or mother-of-pearl. If oysters are grown on a firm, hard surface such as gravel the shell is usually quite fluted; if grown on muddy ground it tends to be smooth. If grown in waters of high salinity the shell is usually quite hard; if grown in waters of low salinity it is soft.

If the right valve is removed, the body of the oyster lies with the mouth at the umbonal or hinge end and posterior at the rounded end. Thus, the long axis of the oyster is actually the height, but common usage indicates this as the length. With the left valve down and hingle to the left, the top side is dorsal and the bottom is ventral.

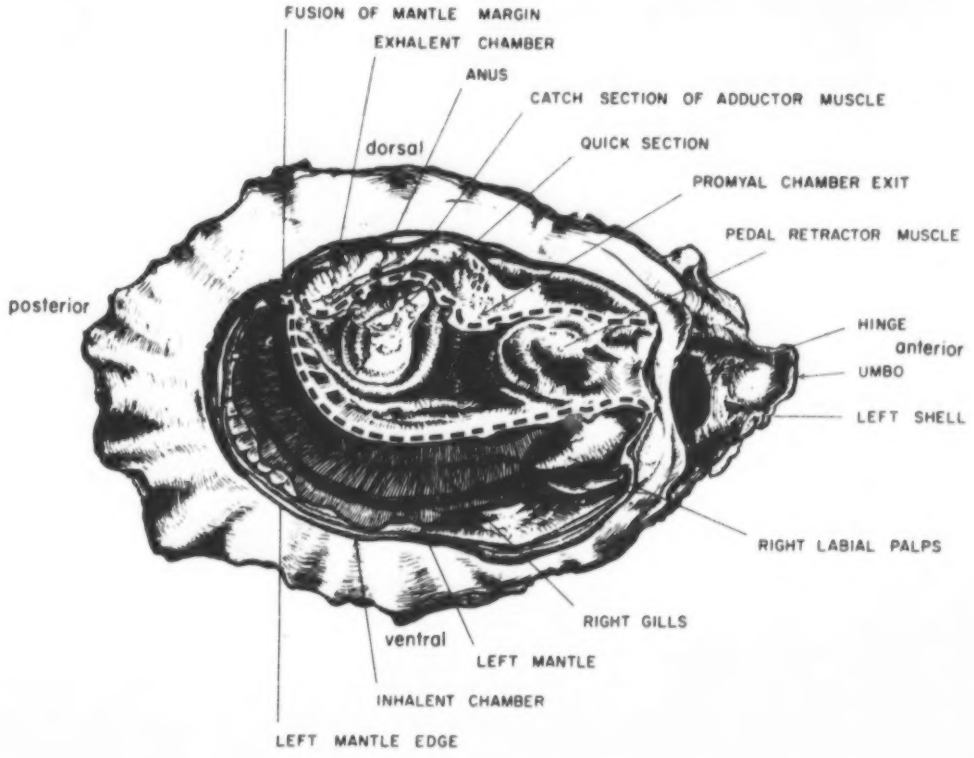

FIG. V. Pacific oyster with right valve and part of mantle removed.

Covering the whole body of the oyster on both sides is the mantle, which in the ventral area takes the form of two thin skirts, thickened at the edges, which are dark in colour. The mantle is the part of the body that secretes shell.

If both free portions of the mantle are removed, at the anterior end there will be exposed four leaflike appendages surrounding the mouth. These are labial palps which serve to prevent large inedible particles entering the mouth. Lying along the whole ventral part of the body are four long, finely ridged beige-coloured appendages which are the ctenidia or so-called gills. They function as both respiratory and food-collecting devices. Rapidly beating fine hairs or cilia on the ctenidial surface create an incoming current of water through the ventral shell gape. Water passes through the basket-like structure of the ctenidia and food particles and other material are strained out and the blood aerated. The filtered water is then passed out dorsally both through the promyal chamber and an area just behind the adductor muscle.

Various tracts of cilia carry the strained particles to the palps and mouth area. If the tissue just anterior to the adductor muscle is removed the heart may be seen. This consists of one ventricle and two auricles which lead into thin-walled blood vessels. The blood is colourless.

The oyster has a simplified nerve system and consists of three distinct groups of nerve cells rather than a single brain.

The reproductive system is a series of branching tubules on each side of the body. During the summer breeding-season these tubes are filled with eggs or sperms. At this time the so-called spawn veins may be seen on the surface of the body. After spawning and during winter the space formerly occupied by discharged reproductive bodies becomes filled with glycogen, which gives a smooth white surface to the oyster body and provides the true oyster flavour.

The digestive system consists of a mouth, a short œsophagus or throat which leads into a pouch-like stomach. At the base of the stomach is a groove which in a feeding oyster contains a yellowish gelatinous rod called the crystalline style. This is an integral part of the digestive system and is a source of enzymes. When the oyster is removed from the water the style disintegrates but is reformed when the oyster is again allowed to feed. The crystalline style is often taken to be a parasitic worm by the uninitiated. From the stomach leads a fairly long thin intestine ending in the anus, which lies just above the adductor muscle.

On either side of the stomach and with ducts leading into it is a series of branched tubes called the digestive diverticula and sometimes referred to as the liver. This is deeply pigmented and in spring and summer, when the oyster is actively feeding, it is dark green or nearly black. During winter, when feeding activity is minimal, the colour is light brown or beige. In a thin oyster the gland may be seen through the body wall.

Growth

Growth in Pacific oysters is extremely variable, both in rate and amount. If an oyster is attached to a solid object, the left or lower valve will follow the contour of that object. If oysters are grown in soft mud they grow long and narrow; this also happens when they are allowed to grow in clusters. When grown on very hard ground, such as gravel, the shape is round and deep, often with extensive shell fluting.

Growth varies with seasons as well as from year to year during similar seasons; it varies with tidal exposure; and it may vary between two closely situated locations at the same tidal height. It is therefore difficult to present a representative growth picture and each grower must learn the growth characteristic of his own ground and its various parts.

There are various definitions of length, width, and thickness, but the ones given here are generally understood by oyster-growers. Growth of oysters may be determined by linear measurements (length, width, height) and by volume. The latter is possibly the most valuable since it incorporates in one figure three linear measurements.

FIG. VI. Three basic shell types of Pacific oyster: A. Round, fluted type from hard gravel X 0.5; B. Smooth type grown on fairly soft ground X 0.5; C. Long, smooth type grown on crowded muddy ground X 0.3.

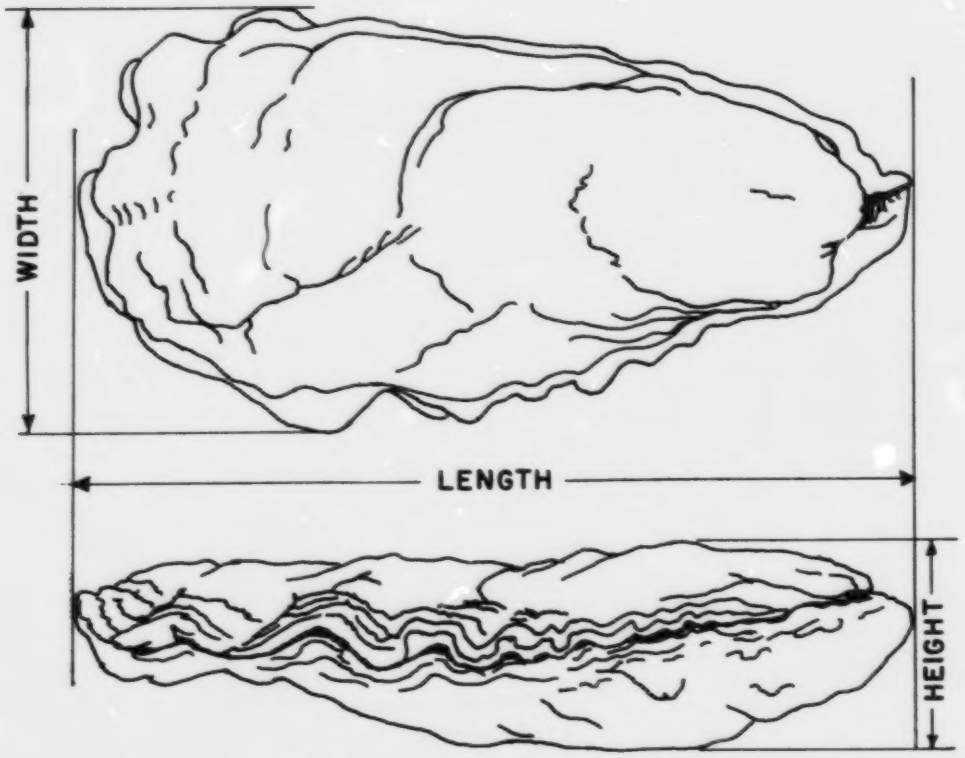

FIG. VII. Diagram to represent dimensional terms applied to oysters.

Growth of oysters in British Columbia is seasonal and related to water temperature. Growth begins in April when water temperatures reach about 9°C and continues through summer until October when water temperatures again fall to below 9°C.

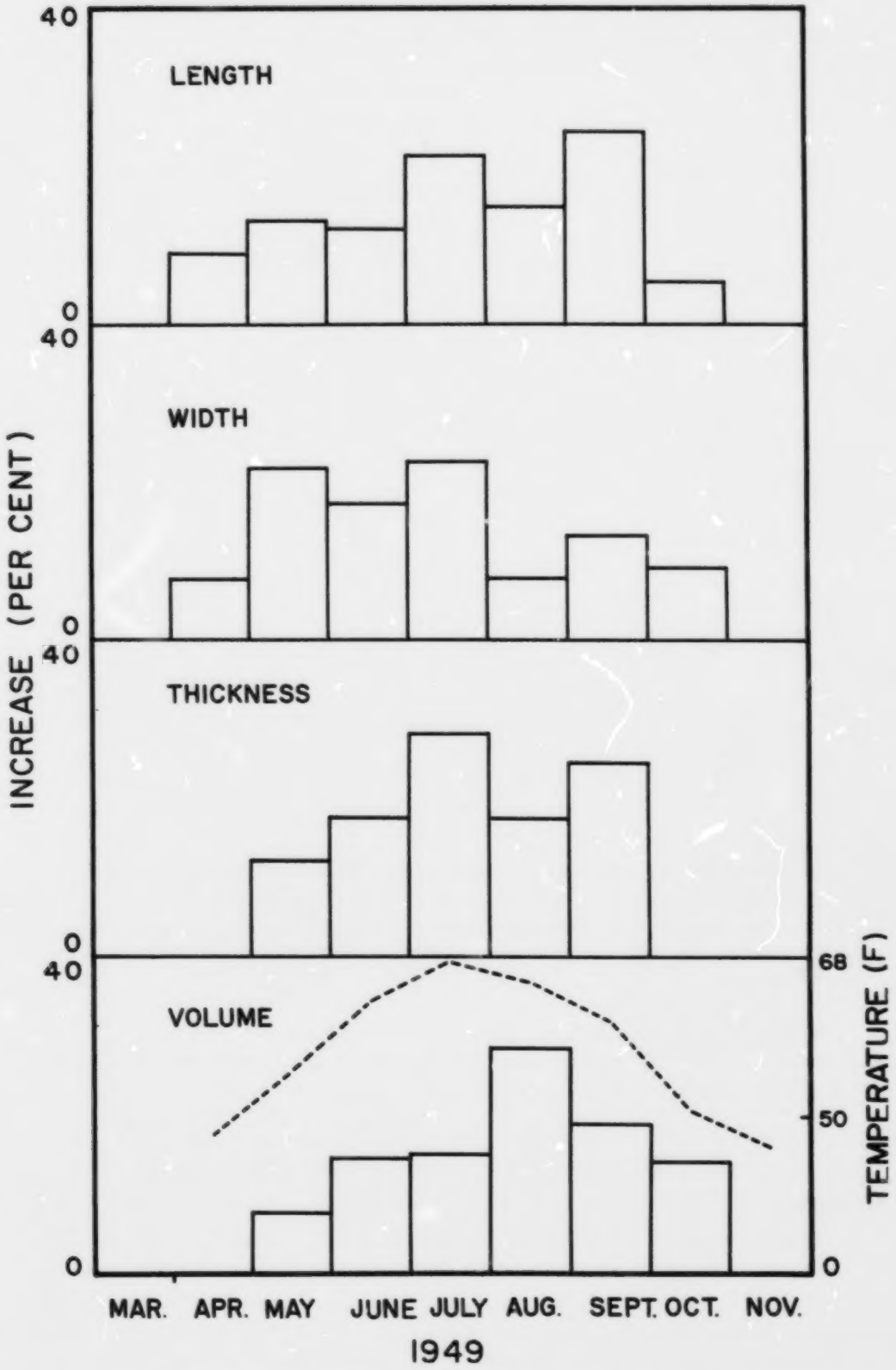

FIG. VIII. Growth of Pacific oysters, Ladysmith Harbour, 1949.

On the average, it requires about three years for Pacific oysters to attain market size in British Columbia and such data for Ladysmith Harbour as shown in Table I and Fig. IX.

Table I—Pacific Oyster Growth in Ladysmith Harbour, Lot 164

(Mean length, volume, and weight of oysters in three cases of Japanese oyster-seed, April 1952–June 1955)

Date	Length (Inches)	Volume (Bushels per Case)	Weight (Pounds per Case)
1952	0.2	1.3	118
1953	2.1	11.6	493
1954	3.8	19.8	1,014
1955	4.3	23.3	1,966

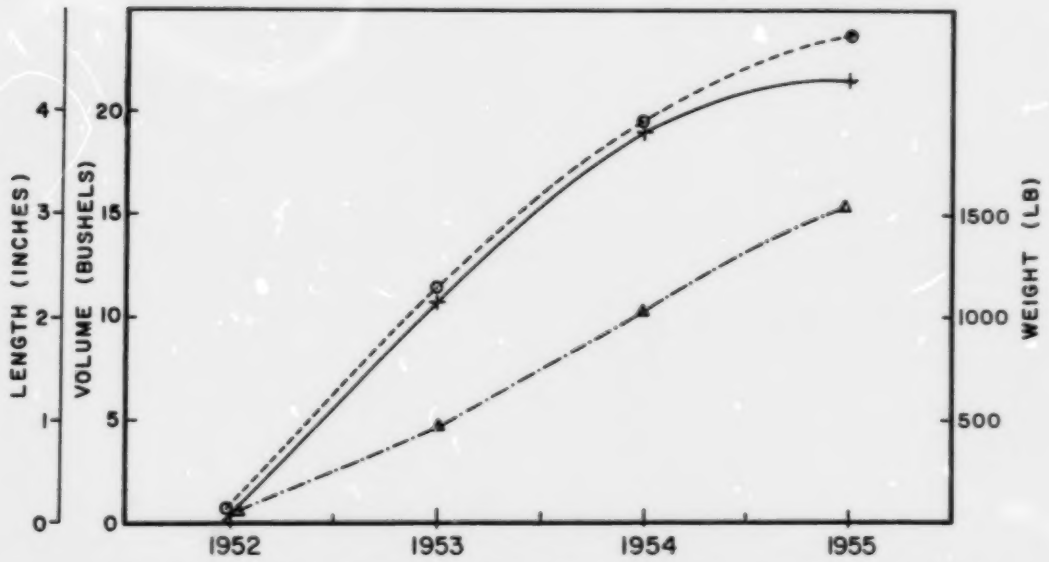

FIG. IX. Growth rate of Pacific oysters, Ladysmith Harbour. Mean shell length (+), case volume (0), and case weight (lb.) (△) of a three-case lot of Japanese oyster-seed.

These data are for oysters on the bottom and if grown on rafts the rate is much more rapid and market-sized oysters have been produced in less than 18 months, although a more normal time is about two years.

OYSTER INDUSTRY IN BRITISH COLUMBIA

History

Three species of oysters have been cultured in British Columbia.

The native oyster, *Ostrea lurida,* the species indigenous to this area, was marketed as early as 1884, but production has virtually ceased as a result of a drastic decline in stocks due to overfishing. There was no serious attempt to culture the native oysters except in Boundary Bay. Small numbers still occur in various parts of the Strait of Georgia and estuaries and tidal pools on the northwest coast of British Columbia.

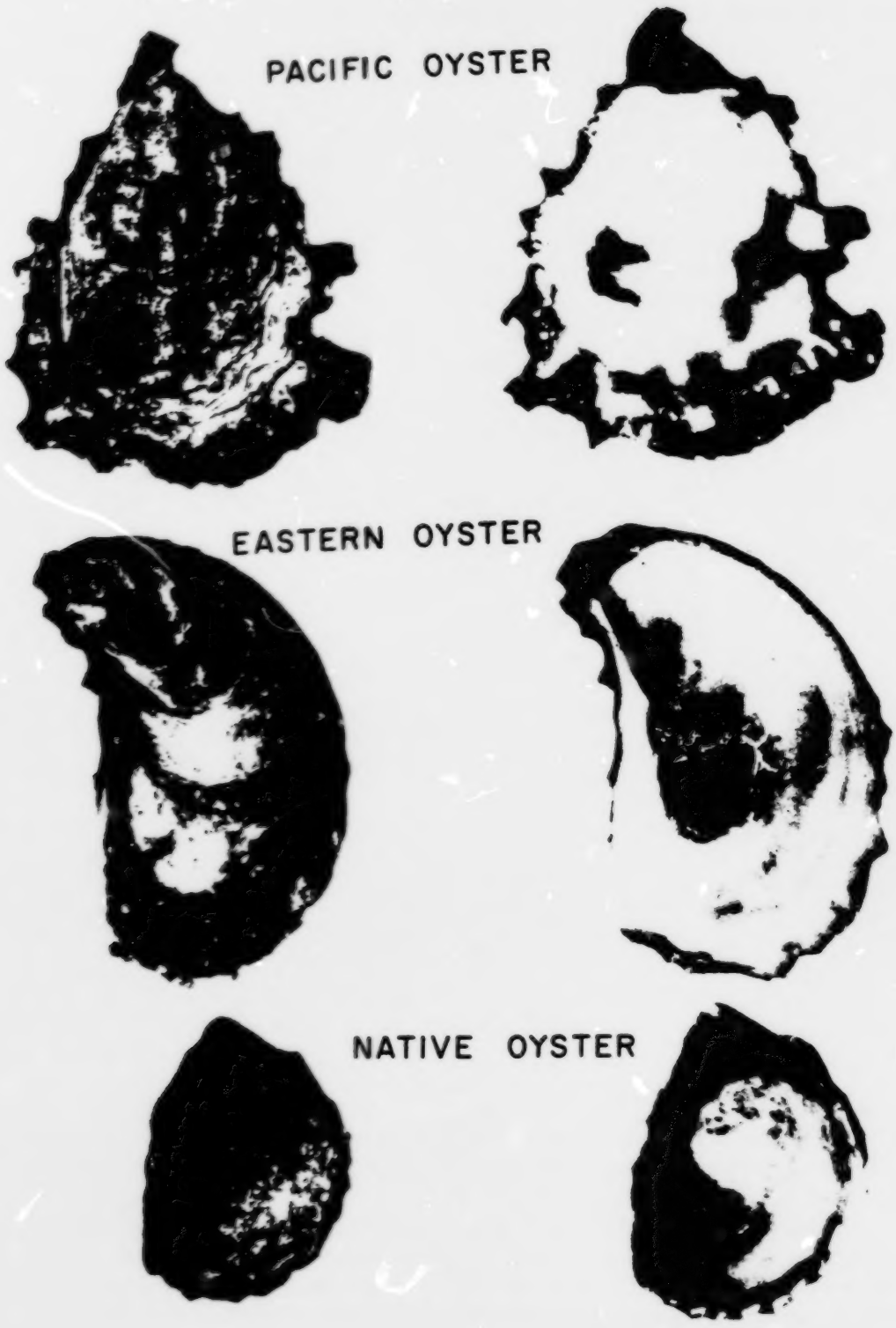

FIG. X. The three species of oysters that occur in British Columbia: Pacific oyster (*Crassostrea gigas*), X 0.5; Eastern oyster (*Crassostrea virginica*), X 1; Native or Olympia oyster (*Ostrea lurida*), X 0.75.

In 1903, Atlantic oysters were introduced into Boundary Bay, Esquimalt and Ladysmith Harbours, but mortality was so high this practice was discontinued about 1940. Populations have declined and now only a few are found in the estuaries of the Serpentine and Nicomekl Rivers which flow into Boundary Bay.

Oyster culture in British Columbia is presently confined to Japanese or Pacific oysters (*Crassostrea gigas*), which were first introduced into British Columbia (Ladysmith Harbour and Fanny Bay) from Japan about 1912 or 1913.

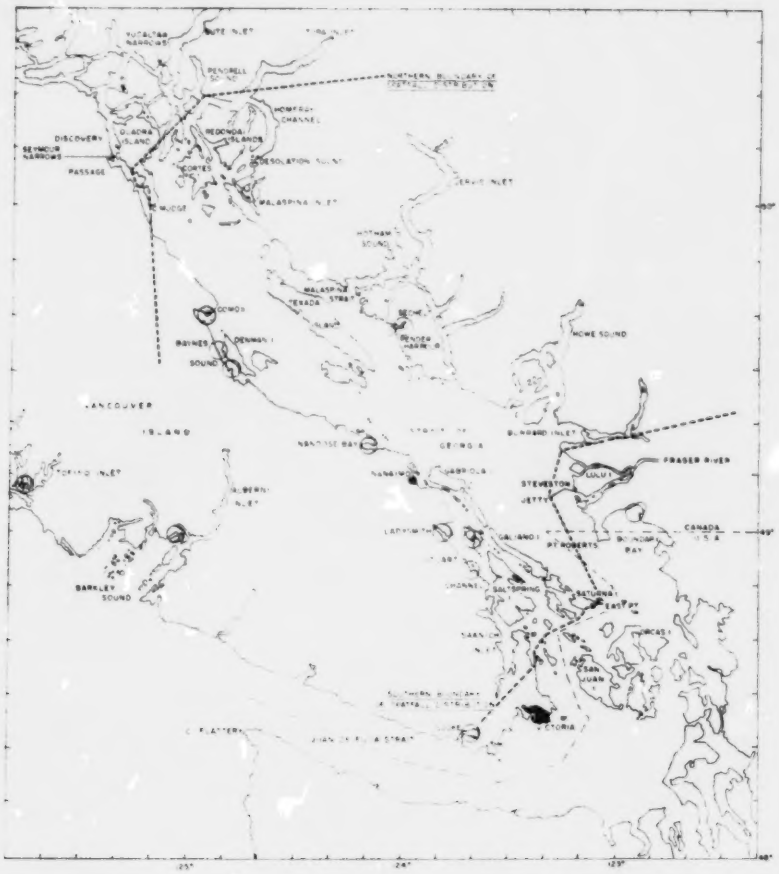

FIG. XI. Map of British Columbia Coast with oyster-growing areas marked in circles. The heavy broken line shows the limits of the 1958 spatfall distribution.

Production was limited, but increased as natural reproduction occurred in Ladysmith Harbour during the 1930's along with significant importation of Japanese seed oysters between 1926 and 1932.

Populations from subsequent plantings of imported seed throughout the Strait of Georgia formed the basis for a general breeding in 1942 which heavily seeded many areas and provided a supply that replaced, in part, the normal requirements for Japanese seed during import cessation at the time of the Second World War.

The importation of Japanese seed was discontinued in 1961 when a widespread breeding of the Pacific oyster in 1958 released British Columbia from dependence on Japanese seed stock.

Status of the Industry

Until about 1930 the British Columbia oyster industry depended almost entirely on the native oyster, but thereafter upon steadily increasing amounts of the Pacific oyster, until at the present time none of the former species is being produced. Since 1960, production has been valued at over $325,000 and has risen steadily to a present landed value of approximately $880,000.

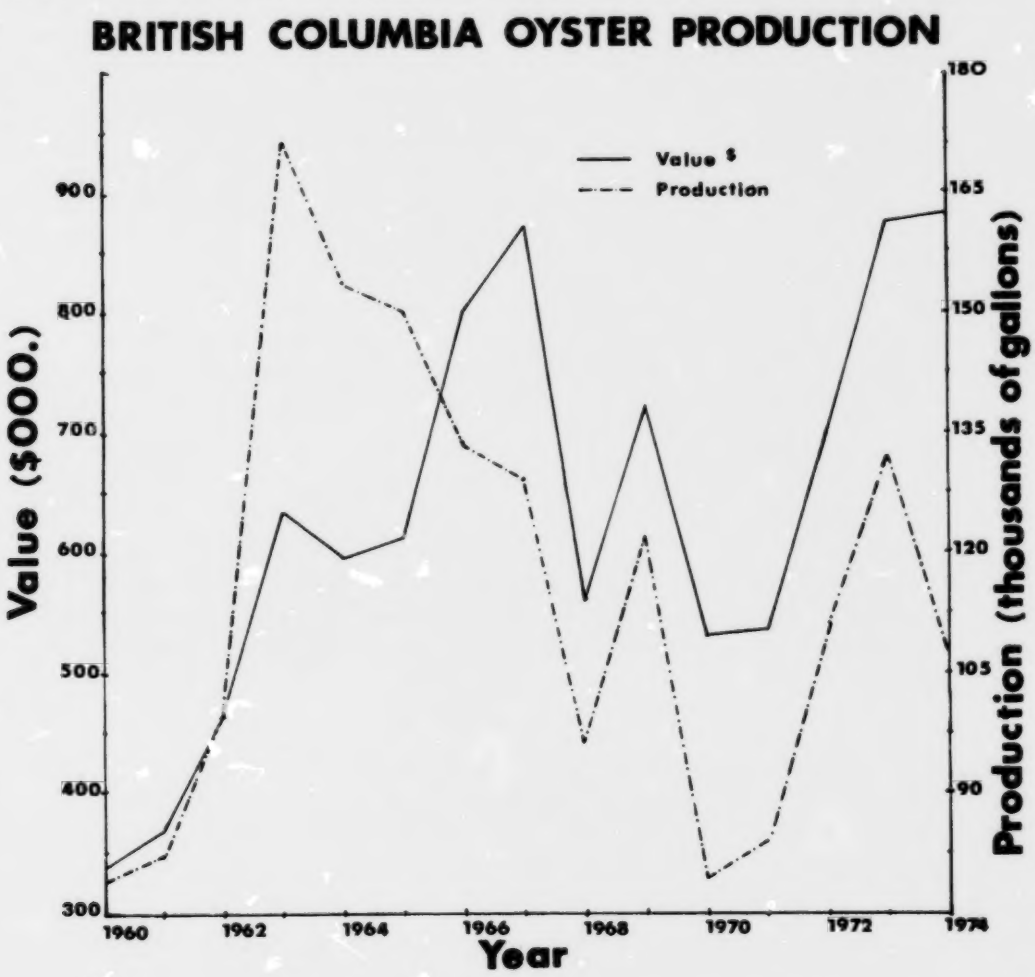

FIG. XII. Oyster production in British Columbia, 1960–74.

Table II—British Columbia Oyster Production

	Production (U.S. Gallons)	Value ($000)
1960	78,384	339
1961	85,164	369
1962	101,165	466
1963	170,375	635
1964	153,449	588
1965	150,676	612
1966	134,336	802
1967	128,345	871

Table II—British Columbia Oyster Production—Continued

	Production (U.S. Gallons)	Value ($000)
1968	96,480	562
1969	121,736	720
1970	79,698	530
1971	84,356	536
1972	110,009	702
1973	131,649	875
1974	108,066	880

Data from Annual Statistics Review of Canadian Fisheries.

Most of this production is derived from beach culture; however, a small trade in the half-shell market has been developed with a well-shaped oyster grown on submerged trays.

The industry consists of 71 registered growers who have under lease from the Provincial Government about 2,000 acres of intertidal and subtidal foreshore for shellfish culture purposes. Nineteen of these growers are on a full-time basis with the remaining growers operating part-time to supplement other sources of income.

The major portion of British Columbia's production originates from the Strait of Georgia with Baynes Sound contributing approximately 60 per cent of this production. Other regions with significant production are located in the Sechelt/Powell River, Ladysmith, and Cortez Island areas. Activity in the Sooke Harbour and Barkley Sound/Tofino regions is presently at a low ebb and contributes approximately 5 per cent to British Columbia's total production.

Organization of the Industry

British Columbia Oyster Marketing Board

The Oyster Board is provided for under the *Natural Products Marketing (British Columbia) Act*, being chapter 263 of the *Revised Statutes of British Columbia, 1960*. It was constituted under the B.C. Oyster Marketing Scheme, 1964, with objectives to promote and control oysters grown in and marketed within the Province, but not over oysters shipped outside of the Province or over import oysters sold within the Province. This Board consists of three members elected from the ranks of the British Columbia Oyster Growers Association.

British Columbia Oyster Growers Association

The BCOGA was incorporated under the *Societies Act* on June 18, 1964, and is comprised of 19 bona fide oyster-growers. The objectives of this association are to promote interests of persons engaged in growing and selling oysters, to provide educational information to its members, and represent the oyster industry in making representations to Governments. The administrative structure of the association is designed so that growers from all the major producing regions are represented on the executive.

GULF OF GEORGIA OYSTER CO-OPERATIVE

The GGOC was incorporated as a limited company on August 22, 1969. The Co-operative is administered by a board of governors appointed by the BCOGA and the Oyster Board. A secretary-manager employed under contract by the Provincial and Federal Governments conducts routine business and is responsible for fulfilling the following objectives of the Co-op.

(*a*) Carry on the business of oyster merchants.

(*b*) Act as agents for producers and shippers.

(*c*) Handle export, buying, selling, and distribution.

(*d*) Establish handling facilities.

(*e*) Advertising and promotion.

OYSTER-FARMING (CULTURE)

Oyster-farming can best be defined as the growing or raising of oysters by a number of methods to improve their quality and increase production potential. Basic methods of oyster culture are relatively few, although there may be many variations of the fundamental techniques.

The first and still the most widely used system is bottom or sowing culture, where oyster seed attached to some form of cultch is spread on suitable bottom and allowed to grow to maturity. Between seeding and harvesting there may be any number or combination of cultural manipulations.

A second, and increasingly popular method is subtidal or off-bottom culture. Here, oysters, either attached in some manner to strings or wires or placed in trays, are suspended from a floating raft so they are completely submerged at all times.

A third method used extensively in some countries is the rack technique, where a framework is imbedded in the bottom and either strings, sticks, or trays are placed on the frame or suspended from it either completely or partially submerged.

A fourth method, still not in extensive use, is stake culture, where a single piece of cultch material with an adequate number of attached seed is placed on the top of a short vertical stake on which the oysters are allowed to mature in a cluster.

The last two methods are sometimes termed near-bottom culture.

Bottom Culture

On arrival the seed is placed in water as quickly as possible and spread either from a boat or scow or by actual dispersal on the beds at low tide. It is spread at a density of approximately 25 cases, or about 200 strings per acre, although this may vary somewhat according to local conditions. Best results appear to be obtained by putting the seed initially at about the 5-foot tide level, although growth may not be quite as rapid as at lower levels.

The seed is then allowed to grow through one full summer, after which clusters should be separated. By this time the young oysters are approximately 1 to 2 inches in length and are growing together in thick clusters of a dozen or so. If they are allowed to grow in this manner they are too close together to obtain maximum growth and the shape is badly distorted. The

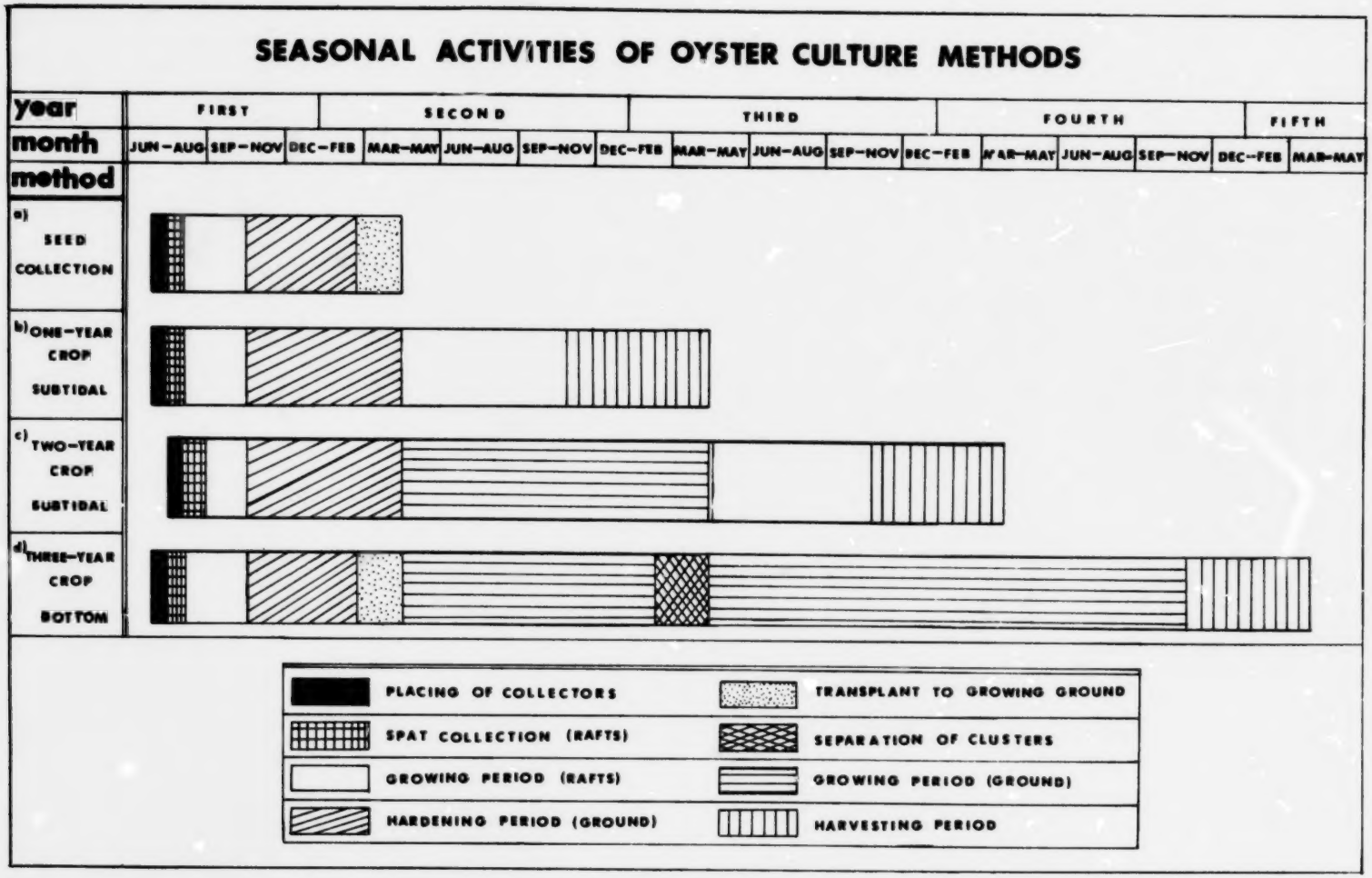

FIG. XIII. Seasonal activities of Oyster-culture methods.

FIG. XIV. Drag dredge for harvesting oysters.

ideal to be sought is production of single oysters, but due to early growth in clusters this is not always possible and groups of two or three oysters are satisfactory. Separation is done by hand or by breaking mother shells with a hammer or a chisel and prying the oysters apart. Some mortality results, up to about 25 per cent, but this is unavoidable, even with considerable care. Breaking clusters is a major and costly undertaking and may only be avoided by the development of some form of cultch from which it will be able to obtain single oysters. Many experiments have been attempted, but not all of them completely successful. Research is being done on this problem. After clusters have been broken, the oysters may be transferred to another section of the beds for further growth if a better-growing area is known or if the seed ground must be released for new seed.

In very favourable localities oysters may be ready for harvesting in the second winter after planting, but in most cases three full summers of growth are required. This again depends on the size at which the grower wishes to market his product.

Harvesting is done by picking by hand or raking the oysters at low tide and shovelling or forking them into a boat or scow which has been properly placed on the previous high tide. If large quantities are to be harvested at one time they may be dredged.

Once in the oyster-house they are washed and immature oysters are culled out for replanting, but if the oysters are to be shucked, culling may be done by shuckers as they work. Shucking is done by hand, using rubber gloves or finger stalls and with a specially shaped oyster-knife. So far no satisfactory mechanical method for shucking of raw oysters has been developed. After shucking they are washed and packed, then stored in a refrigerator at a temperature below 50°F.

Off-bottom Culture

(RAFT METHOD)

Culture of oysters by suspending them from rafts has been practised in several countries, such as Norway, France, and Japan, for many years. The amount of oyster-ground in British Columbia is relatively small due to the precipitous nature of the coastline; but there are numerous sheltered coves and bays that are suitable for raft culture.

Shells holding Pacific oyster spat are strung on No. 12 galvanized wire and held apart by twists in the wire about 6–8 inches apart. Shells are separated to allow the spat to grow freely in all directions. A small tool has been developed for making twists in the wire. New materials such as polypropylene cord, vinyl-coated nylon cord, or vinyl-coated galvanized wire must now be considered as alternatives to plain galvanized wire.

Strings may be made up either as "singles" where 15 shells are placed on the wire and hung from a nail on the raft; or as "doubles" where 30 shells are placed on a single string, each group of 15 shells being separated by 2–3 feet of blank wire. These double strings are draped 12–18 inches apart over the logs of the raft so that 15 shells hang from each side and in this method nails are unnecessary, reducing both losses and handling costs.

There are no definite standards of raft construction as almost any type strong enough to withstand the buffeting of wave action would be suitable.

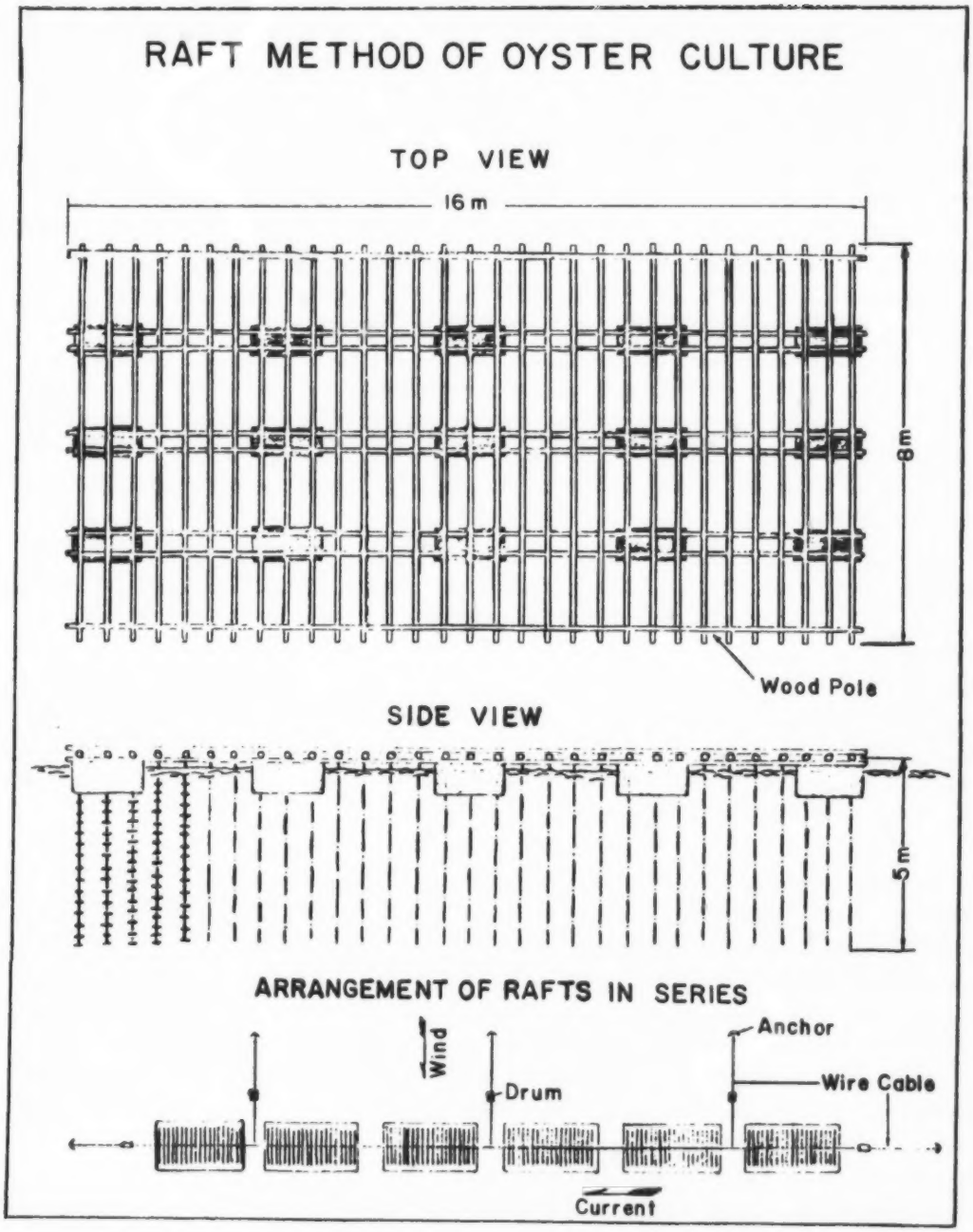

Fig. XV. Perspective drawing of raft method of oyster culture as practised in Japan (Cahn, 1950).

The rafts are placed in water where depths at the lowest tide exceed the length of the string, so ends of the string do not touch bottom. Compliance with terms of the *Navigable Waters Protection Act* is necessary and deep water foreshore leases should be obtained.

Under normal circumstances the strings are placed on rafts in spring and no further care is necessary until harvesting, which may begin in mid-November or December (*see* Fig. XIII).

Either local or Japanese seed may be used and the initial cost is about the same. Local seed has the advantage that the shells are larger and harder, allowing more space and security for attachment of the growing oysters.

There are two methods of harvesting. One is to move the whole raft into the intertidal area at high tide where the strings are dropped off so they may be picked up at low tide. The other method is to lift the strings directly from the culture raft with a derrick or A frame on another raft or scow.

Seed should have a minimum diameter of about an inch before it may be expected to attain market size in the March to November growing period. Unless the local set has occurred very early in the summer, the above conditions are seldom met and the only way in which minimum size may be obtained is to hold seed on the beach for a year before rafting. If seed less than about 1 inch in diameter is used, too low a proportion of marketable oysters is yielded in one growing-season. Two growing-seasons on the rafts are not considered advisable since there is relatively little additional growth in the second year, fouling becomes a significant problem, and valuable float space is also occupied.

The objective should be to obtain about a gallon of oysters per string which represents 100 to 150 oysters of market size. In addition to seed size, an important factor in governing the yield per string is the initial number of spat and the ideal number appears to lie between 10 and 20 spat per shell. If there are less, mortality losses, in addition to undersized oysters, reduce the number below that required to yield one gallon per string. If there are more than about 20 spat per shell there is competition for space and for food, and with the resulting mortality and slow growth, there are again less than the number required to yield one gallon per string.

The raft method of oyster culture has been shown to have a number of important advantages over beach culture. First, average growth rate is reduced from an average of three years to two years and in some cases to slightly over one year. The appearance of the oyster meat is generally good for the mantle is not as dark as in those oysters grown on the beach. At all times they are fatter than those grown on the shore only a few hundred yards away.

Since the oysters are held off the bottom, mortality does not occur from silting or from predators, such as starfish or drills. Further, the operations do not depend on low tides.

(Longline Method)

The longline culture method is a modification of the raft technique developed in Japan. It seems to be a definite step forward in oyster-culture procedures. The method is primarily a flotation technique designed to eliminate the raft.

The basic longline unit consists of a series of wooden barrels (or other suitable flotation) and arranged in rows, resembling a skeleton plan of a raft. Each row of barrels supports below it two parallel longlines of 6-centimetre rope. A single row is from 70 to 75 metres long and contains 12 floats spaced 7 metres apart, with an interval of 10 to 15 metres between the two middle barrels.

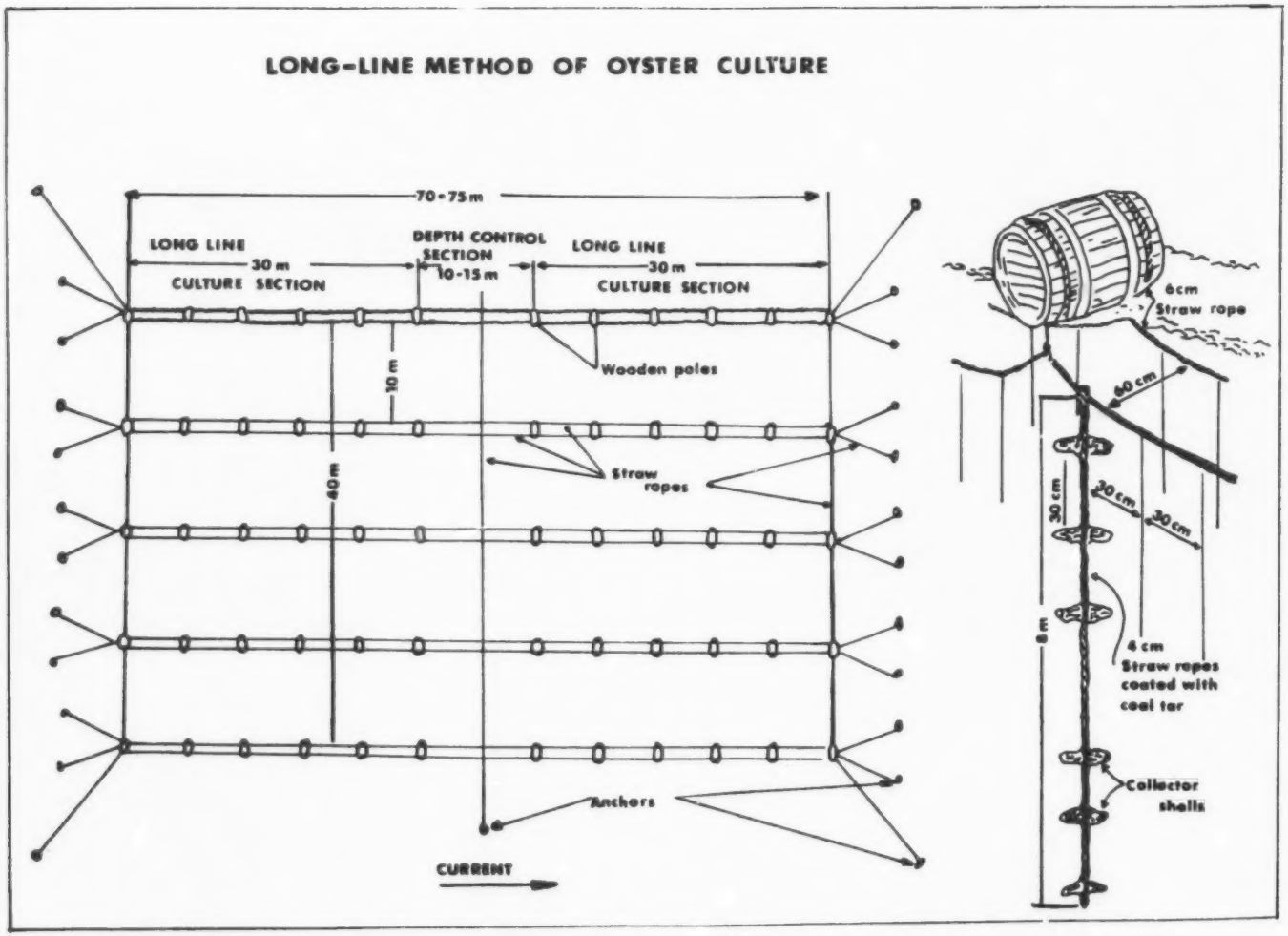

FIG. XVI. Perspective drawing of longline method of oyster culture as practised in Japan (Cahn, 1950).

This technique of oyster culture has all the advantages of the raft method, but offers an additional advantage in that the longline method is wholly flexible and uses no exposed raft that can be subject to damage by wind and waves.

(TRAY METHOD)

Tray culture of oysters is a relatively new method that is now being practised in British Columbia. Some countries, such as Norway and Scotland, have employed this technique for a number of years in areas where a traditional oyster-fishery has not existed previously.

This technique offers all the advantages of other off-bottom culture methods such as fast growth, lighter-coloured mantle, fatter oysters, and higher survival, but also provides a consistently well-shaped and deep-cupped oyster. Tray-cultured oysters are marketed exclusively for the half-shell trade where they are served as hors d'oeuvres fresh in the shell on ice with lemon wedges or seafood sauces. These oysters are harvested when they reach a length of 90–100 mm and a weight of approximately 75 grams.

At the present time there are two modifications of the tray-culture method being employed in British Columbia. One method utilizes Nestier trays, which are suspended in five-tray bundles from float platforms by a rope bridle which is fastened with a halibut snap. The trays are banded together by plastic banding and buckles which are reusable. The snaps provide for a rapid method of attaching, detaching, and separating the bundles of trays during the thinning, cleaning, and marketing processes.

The Nestier tray operation employs a two-year production cycle. Approximately 2,000, 10 mm in length, seed are placed in each individual tray in March. The trays are cleaned and thinned every month and by the end of the growing-season (November) the seed density is reduced to approximately 200 per tray to allow for the increase in the oysters' size. The oysters have attained a size of approximately 40–50 mm in length by this time.

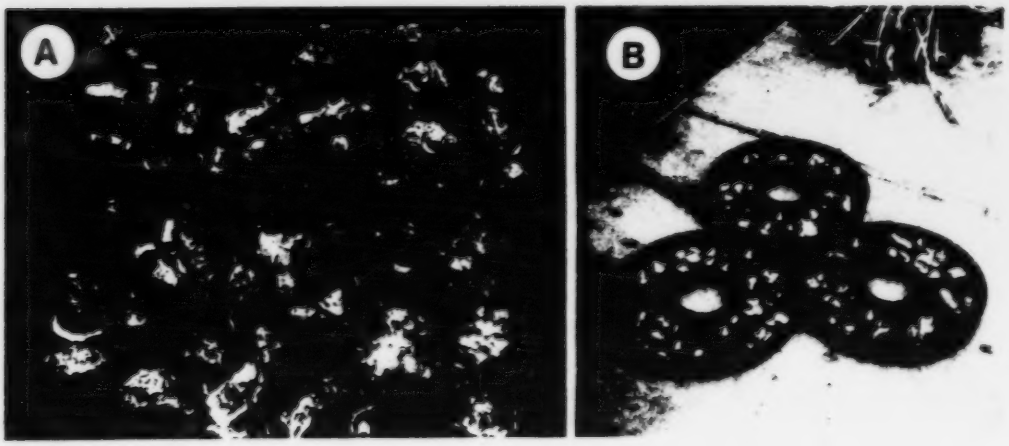

FIG. XVII. Oyster-culture trays—A. Nestier tray; B. McNichol tray.

The following growing-season (March to November), the oysters are thinned and cleaned every month similar to the previous year. At the end of the second growing-season, the number of oysters has been reduced to 50 per tray, and they are now at market size, 90–100 mm in length and weighing approximately 75 grams each.

The second modification of the tray-culture method being practised in British Columbia employs a longline system to suspend the so-called McNichol tray (Fig. XVII). This tray is said to have a number of advantages over the Nestier tray. The unique design of the tray provides for greater water circulation resulting in faster growth and easier handling during the thinning and cleaning process. This tray, however, holds approximately two dozen market-sized oysters, one half of that of the Nestier tray, but the McNichol tray costs about $1 each compared to $5 for the Nestier.

The operation utilizing the McNichol trays is based on a one-year production cycle. Seed measuring 30–40 mm at a density of 75 oysters per tray are placed out in bundles of nine trays suspended from a longline at the beginning of the growing season (March). The number of oysters per tray is reduced to approximately 24 by the end of the growing-season when they reach market size of 90–100 mm in length.

Near-bottom Culture

(Rack Method)

Another method of growing Pacific oysters, which is little used as yet in British Columbia, is by means of racks. This permits utilization of very soft oyster bottom and is a means of extending oyster bottom for a short distance into the subtidal area.

Fig. XVIII. Rack culture of Pacific oysters, Ladysmith Harbour.

Racks of 2 by 4-inch lumber are usually stout enough, but they should be creosoted for long life. Posts are driven into the ground and joined by caps both lengthwise and crosswise. The actual dimension and shape is not fixed and may vary according to the bottom available and to the extent of the rack system. Enough space should be left between individual racks to

allow easy handling of shell strings. The shells are strung on wire as for raft culture but usually they are not longer than about 4 feet. The top of the racks in the intertidal area should not be above the 5 or 6-foot tide level.

To utilize the subtidal margin of an oyster-bed by racks the posts are driven so that the top of the racks are about 1–2 feet above zero tide level. This limits working time, but the strings are only handled and harvested when exposed, so this is not too important a consideration.

The growth rate on intertidal racks is on the average midway between those for bottom and raft cultures.

(STAKE METHOD)

This is a method that has been used in Washington and California. It consists simply of a stick of wood usually about 1 inch in diameter and about 18 inches in length with a 2-inch nail driven part way at one end.

FIG. XIX. Stake culture of Pacific oysters, Ladysmith Harbour, showing cluster of oysters on 1 by 1-inch stake.

The other end is pushed down into the bottom nearly a foot and a single-seeded oyster cultch shell is placed on the nail through the hole in the shell. If the shell is the left valve, the cup side should be placed downward to prevent being filled with silt. The sticks are placed about a foot apart with lanes every few feet to allow planting and harvesting. The sticks should be creosoted for long life. Seed of any size may be used. The growth and survival rates are superior to those for bottom culture.

At first glance the method may appear uneconomical, but when it is considered that about 10 oysters may be grown to market size on a single stick, the system has merit under certain conditions as on very soft ground.

Economics of Culture Methods

The economics of oyster culture are difficult to determine because of the wide range in culture methods, the suitability of growing areas, and in the efficiency and size of particular operations. The estimates provided are based on information derived from the oyster industry, and analysis of experimental culture operations conducted by investigators.

(BOTTOM CULTURE)

The following estimates are based on a 5-acre area with planting density set at 25 cases of seed/acre. Production is estimated at 125 tons of shellstock based on a three-year cycle, assuming that conditions for oyster culture are optimum. No account has been taken for capital investment nor for a number of smaller items.

Table III—Cost of Production of Shellstock (1976)

	$
Lease fees	225 ($75/year)
Lease taxes	150 ($50/year)
Seed costs	2,500 ($20/case—125 cases)
Spreading seed	200 ($1.65/case)
Breaking seed	1,000 ($8/case)
Transplanting	1,125 ($15/ton)
Harvesting	3,750 ($30/ton)
Total cost	8,950 ($71.40/ton)

The landed value for oyster shellstock (table grade) is approximately $80/ton, and when compared to the production costs, it is apparent that this culture method is a marginal business enterprise. The profit margin picture improves considerably when the oyster-grower operates his own shucking facility as indicated in the following estimates:

Table IV—Cost of Oyster Production per Shucked Gallon (1976)

	Per Gallon
	$
Lease fees and taxes	0.15
Spreading, breaking, transplanting, and harvesting	1.95
Shucking	2.25
Freight	0.30
Cartons	0.90
Plant overhead	0.25
Grading and packing	0.50
Marketing board	0.10
Seed	0.75
Total cost	7.15

The wholesale price per gallon is presently $11, which would realize a gross profit of $3.85. It must be noted again that no account has been taken for capital investment.

The estimates provided in Tables III and IV clearly indicate that the major costs of oyster production utilizing bottom culture are on the beach, and the profit margin is realized in the shucking shed.

(RAFT CULTURE)

The basic production costs involved in raft culture are approximately the same as for bottom culture. The big advantage of raft culture is the increase in productivity utilizing this method. A raft will produce twice as many oysters as bottom culture from one unit of seed and about 10 times as many oysters as from the bottom in equivalent areas (Quayle, 1971).

Table V contains a list of the items and activities with their related costs derived from an experimental operation on a 40 by 10-foot, two-log raft with 100 strings per raft being cultured (Quayle, 1971). The costs listed are probably maximum and more economical methods can be applied especially on a commercial scale. However, no consideration has been given for capital expenditures associated with the culture method (e.g., boat, etc.).

Production from 15 pieces of cultch (15–20 spat/shell) has been estimated by Quayle to produce a gallon of shucked oysters. The estimated cost of producing a gallon of oysters with the raft method is $3.51. The present wholesale value of a shucked and packed gallon to the producer is now $11 (1976). Custom shucking is possible, and the general costs, including freight and packing are about $3.15 per gallon. This brings the total cost per gallon, when operational costs are considered, to approximately $6.66, which compares favourable to beach-culture costs ($7.15/gallon).

Table V—Cost of Oyster Production by Raft Culture

	$
Logs: $25 each from log salvor; towing, $35	85.00
Anchor rope: ⅝-in. polypropylene (20 fath)	20.00
Cement anchors: 2–260 lb.	20.00
Two ½-in. eye bolts	4.50
Four ¾-in. thimbles	3.50
Eight ½-in. block iron drifts with clinch rings	6.00
Four ⅜-in. shackles	8.00
Two 3-in. by ½-in. by 12-ft. cedar beams	20.00
Labour (construction)	50.00
Miscellaneous	20.00
Total raft cost	237.00

Annual cost per raft (three-year life) $\frac{237}{3} = \$79.00$

Wire: 100 single strings (1,100 ft. of wire, No. 12 galvanized)	28.00
Cultch: 1,500 pieces at 4 cents	60.00
Spreading cultch	4.00
Harvesting cultch	10.00
Stringing cultch	40.00
Hanging strings	10.00
Harvesting	20.00
Separating clusters and defouling	35.00
Lease fees and taxes (1-acre minimum fee)	50.00
Miscellaneous	15.00
Total operating costs	272.00
Annual cost of raft, plus operations	351.00

Production: 1 gal. per string = 100 by 1 = 100 gallons

Cost per gallon (equipment and operational) $\frac{351}{100} = \$3.51$

(TRAY CULTURE)

The economics of tray culture have been analysed in detail by Humphries (1976). The following estimates are based on his results on the production of 10,000 dozen oysters utilizing the Nestier tray supported by floating platforms. No account has been taken for a number of capital expenditures or general business costs.

Two-year production cycle—Flotation costs are estimated at approximately $5 per linear foot on a two-sided float, and can be amortized over three years at $1.67 per foot per year. The Nestier tray is assumed to have a life expectancy of 10 years and at an initial cost of $5 per tray, the yearly cost/tray would be $0.50. Labour costs were assessed at $3 per hour. Materials for banding and hanging of trays averages about $0.10/five-tray set/month. Seed costs are extremely variable depending on the type and source. Panel seed costs $3 per 1,000, plus $5 for labour for separating. Diamond chip and hatchery seed costs $10 per 1,000.

Table VI—Production Costs of Tray-grown Oysters
(Nestier tray, two-year cycle)

Year One	$	$
Seed: Panel type (160,000 seed @ 8/1,000)	1,280.00	
Other types (160,000 seed @ $10/1,000)		1,600.00
Trays: 720 @ $0.50/yr.	360.00	
Labour: 335 hours @ $3/hr., 10–15 min./tray	1,005.00	
Flotation: 180 lin. ft. ($1.67/lin. ft./yr.)	300.00	
Materials for banding ($0.10–$0.15/set)	50.00	
Total using panel seed	2,995.00	
Total using other seed		3,315.00

Year Two	$	$
Trays: 2,880 @ $0.50/yr.	1,440.00	
Labour: 2,040 hours @ $3/hr.	6,120.00	
Flotation: 720 lin. ft. ($1.67/lin. ft./yr.)	1,200.00	
Materials for banding ($0.10–$0.15/set)	200.00	
Total	8,960.00	
Total for two years using panel seed	11,955.00	
Total for two years using other seed		12,275.00

The direct costs of producing 10,000 dozen oysters will be between $11,955 and $12,275 or $1.20 to $1.23 per dozen.

The cost of harvesting and packaging 10,000 dozen oysters has been estimated at $1,670 (Humphries, 1976). This would bring the total production and marketing costs to between $13,625 and $13,945 or $1.36 to $1.39 per dozen. The present wholesale value for tray grown oysters is $3.10 per dozen, realizing a gross profit (not including major capital and business expense) of $1.71 to $1.74 a dozen.

One-year production cycle—The costs of a one-year production cycle have been estimated to be slightly higher due to increased seed costs. Seed of approximately 40 mm in length would have to be purchased at a cost 400 per cent higher than 5–10 mm seed which would raise the production and marketing costs approximately $0.20 a dozen to $1.91–$1.94. There are certain advantages, however, as the space, flotation, and number of trays needed is less, and probably most important, the element of risk of loss from storms and other sources is reduced.

AREAS SUITABLE FOR OYSTER-FARMING

The area selected for oyster culture is extremely important as an oyster-farmer's success is decided to a great extent by the conditions under which he works. The commercial culture of oysters depends on selecting a locality where both the necessary water characteristics and bottom type occur together. The choice of oyster-ground that will satisfy the particular needs of the prospective grower is therefore, an important and complex problem.

British Columbia, because of its precipitous shoreline, has little good quality oyster-ground. Firm, flat, well-protected tidelands suitable for oyster culture, occur mainly in river estuaries and this is where population centres and industries develop, so there is a land use conflict. There are only about 3,000 acres of usable oyster-ground and most of this is either already under lease or restricted because of sewage or industrial pollution. Thus potential productivity from bottom culture is limited.

However, in addition to good quality oyster-ground, there is probably an equal amount of what may be termed marginal ground. This is so designated because it may be at a high tidal level, is too soft, or not well enough protected. High ground may be physically lowered by bulldozing or it may be used for growing seed for unusually high ground is firm ground and silting mortality is minimal. Growth may be slow but compensated for by increased survival. Soft ground may be used for stake or for rack culture or it may be hardened by filling with layers of whole oyster-shell followed by crushed shell or gravel. Exposed ground may be protected by some form of breakwater such as a row of anchored boom-sticks.

However, with the indented coastline of numerous deep, well-protected bays, there is almost unlimited potential for raft culture. A conservative estimate of production possible from raft culture in Georgia Strait alone is placed at 3 million gallons, equivalent to 12,000 tons of oyster meat per year. Here, because of relatively high summer water temperatures, oysters grow more rapidly than elswhere in British Columbia.

The Marine Resources Branch provides an advisory service on selection of oyster-culture sites. Final selection is the responsibility of the grower,

but he would be wise to have the ground examined and to obtain outside opinions on its suitability.

Environmental Conditions

Water Quality

Pacific oysters are extremely hardy and can withstand wide variations of temperature and salinity, but site selections should provide as close to optimum conditions as possible. These conditions occur widely, but the main problem is to find fertile water in which oysters will grow rapidly and fatten well. Moderate currents help growth and fattening, but this type of water cannot be easily recognized and is generally located only by trial and error, using the oysters themselves. In addition, the water must be free of industrial and sewage pollutants.

Type of Bottom

When bottom culture is considered, selection is based mainly on three factors—tide level, bottom consistency, and protection from wave action.

(*a*) *Tide level*—In the Strait of Georgia wild populations of the Pacific oyster generally are located between the 5 to 8-foot tide level, this being the area of greatest survival. Oysters are cultured commercially between the 2 to 5-foot tide level, where faster growth rates normally are attained.

(*b*) *Bottom consistency*—This factor is of equal importance for unsuitable bottom consistency results in a number of unfavourable conditions such as oysters being moved by the slightest wave action, when grown on solid rock; or poorly shaped oysters when grown on soft bottom. The ideal bottom type is one of firm sand-mud-gravel which is associated with low mortality, ideal shape, and minimal movement.

(*c*) *Wave action*—Proper protection is an essential factor, for excessive wave action can move oysters, windrowing them, breaking off new shell growth, and stirring up bottom sediment, thus inhibiting the feeding process. Observation of prevailing wind conditions and drift characteristics in the intertidal area provide valuable information in assessing this factor.

It is often difficult to find ideal levels for all three factors in one area and it may be necessary to compromise on at least one of them.

COLLECTION OF OYSTER-SEED

The Pacific oyster industry in British Columbia is based on the principle of bringing seed oysters from external sources to the growing areas. Therefore, a dependable seed source is an essential requirement for a viable oyster industry. British Columbia is fortunate in having reliable seed producing areas such as Pendrell Sound and Hotham Sound (*refer* Fig. XI).

Oyster seed or spat is collected by placing a suitable substrate called "cultch" to which oyster larvæ will attach into the water column at the appropriate time or place. Cultch may consist of a variety of materials but only a few are utilized because of practical and economic considerations.

Oyster-seed Collectors

Oyster Shell Cultch

In British Columbia seed is collected mainly on oyster-shells that are strung on wires of 5 or 6 feet in length.

Fig. XX. Double shell cultch string.

The main advantages of shell cultch are low cost and availability, while the disadvantages are heavy weight, hardness, and strength. The weight of the cultch requires considerable flotation power when suspended from rafts and quite heavy lifting gear if it is to be handled in quantity. Hard, strong shell, together with its large size, creates problems in separating clusters.

Cement-coated Veneer

Another type of cultch that in recent years has gained a degree of popularity in British Columbia is strips of wood veneer of spruce or fir that are coated with a layer of cement. These strips are supported in a frame of galvanized wire or stapled together in circles for support to facilitate exposure and handling.

Fig. XXI. Cement-coated veneer cultch.

The advantages of this type of cultch are light weight, approximately one-tenth the weight of shell cultch of comparable surface area, and the fragile nature of the veneer facilitates the separation of the oyster-seed. The disadvantages are availability and higher costs of materials and labour.

EXPOSING CULTCH

Cultch may be exposed for collection by spreading it in the intertidal area or on intertidal wooden racks that hold packaged cultch such as shell-strings. These methods have many disadvantages, most significant of which is the limited collection time by noncontinuous submergence.

Raft suspension is the most efficient due to constant submersion and is more costly. However, increased spat-collection efficiency and reliability offsets increased costs resulting from flotation expenditures. This method of collection is used almost exclusively in British Columbia.

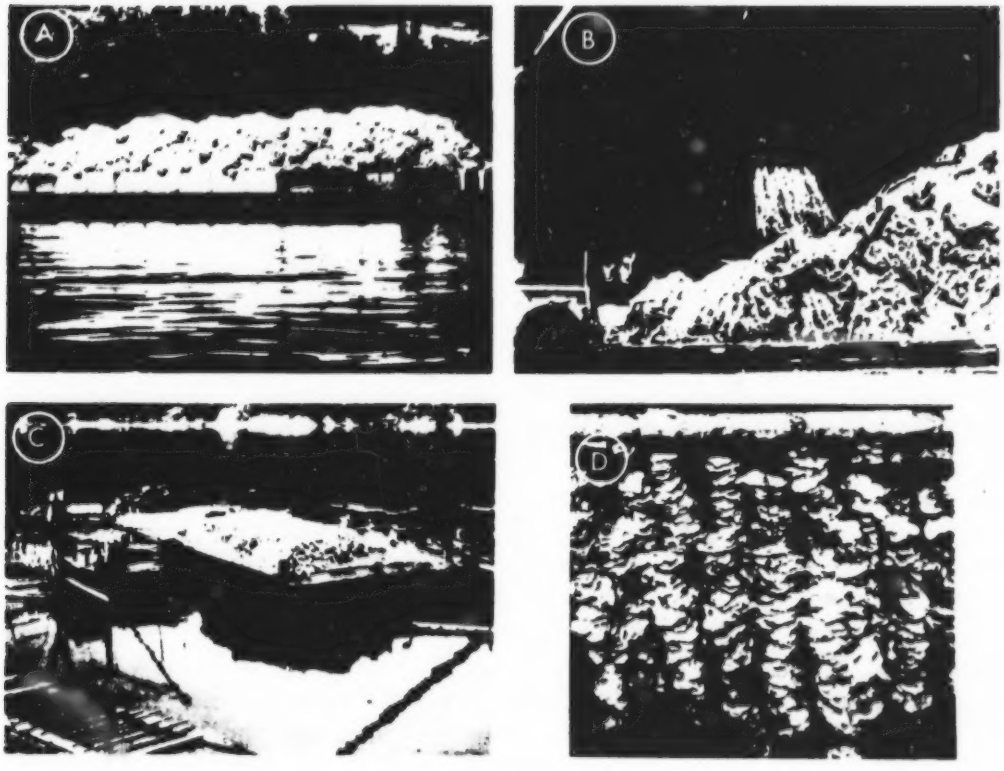

FIG. XXII. Shell cultch operation, Pendrell Sound: A. Scowload of shell strings; B. Unloading shell strings which have already been hung on wooden poles; C. Setting the string-loaded poles on the raft; D. Shell strings hanging in the water.

PLANTING AND STORAGE OF OYSTER-SEED

While breeding success of the Pacific oyster in British Columbia, particularly in Pendrell Sound, has been of a relatively high order since 1950, failures are possible and have indeed occurred on occasion. If there is no alternative supply there may be a significant interruption in the even flow of marketable oysters. One obvious solution to this possibility, alternative to the use of hatcheries, is the stockpiling of at least an additional one year's supply of seed in years of abundance. This is particularly important in the case of seed producers.

The storage process is simply enough and requires the use of relatively high (6 to 10 feet in a tidal range of 16 feet), solid, and well-protected ground. Generally this type of bottom is firm because little siltation is possible. Consequently, there is virtually no silting mortality and predators rarely occur at this tidal level. Thus the only source of mortality is from competition for space on the cultch. Also, the longer the storage the greater the fragility of the cultch so cluster separation is more readily accomplished.

The type of ground for storage is what may be termed marginal for it cannot be used for the full cycle of culture. However, it may be integrated into the culture system either as a separate entity whose sole purpose is the supply of 2 to 3-inch seed to other growers, or by releasing ground normally used for seed but which would be put to better use as growing ground with which British Columbia has a limited supply. Oysters of the type and size grown in this manner may be planted and grown on soft ground on which

normal seed would suffer considerable silting mortality. Further, seed oysters of this type are better able to withstand predation by oyster drills.

CONDITION OF OYSTERS

Oysters undergo an annual cycle during only a part of which are they "fat" in the true sense of the word. When oysters are plump and fill the shell cavity they are said to be in good condition and this may be measured quantitatively by comparing the amount of meat (usually the dried weight) to volume of the shell cavity. This ratio is called the "condition factor"; however, the condition factor may be high either from fat or from spawn.

In late summer after spawning, when the oyster has discharged all of its reproductive products, it is thin and watery and is unattractive in appearance with little food value or flavour. Soon after spawning, however, the body of the oyster begins to fill out with production of an animal fat called glycogen and this is an even-textured white material characteristic of oysters during winter. If food conditions during the fall are satisfactory, by the end of November, when all oyster food has disappeared from the water, the oyster will be quite plump with glycogen and the body fills most of the shell cavity. The oyster maintains this condition with little variation throughout winter. When water temperatures rise in spring and food again becomes available, the oyster may further add to its glycogen store and as a rule, during April and May, most oysters are at their best. In late May and June increased water temperature causes conversion of glycogen to reproductive products and by late June the change has usually been completed. A large proportion of the oyster body is now reproductive tissue and, while it is perfectly edible, it does not have the true winter oyster flavour. The seasonal cycle of condition is shown in Fig. XXIII.

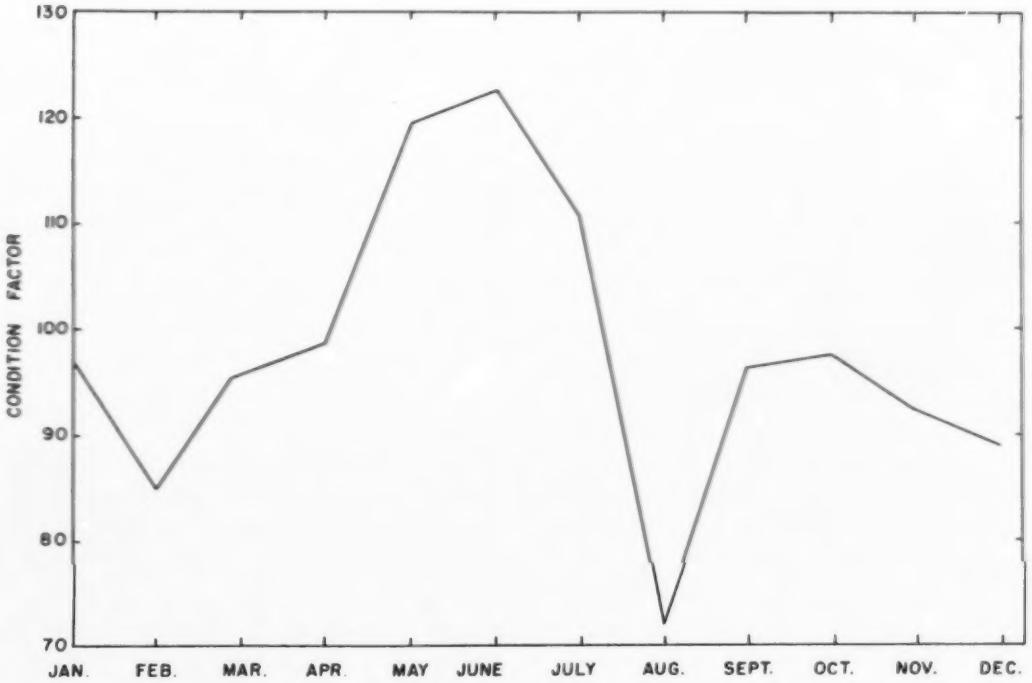

FIG. XXIII. Seasonal variation of the condition factor of Pacific oysters in Ladysmith Harbour. Mean of 148 samples, 1952–56.

PREDATORS AND PESTS

British Columbia is fortunate in having relatively few predators and pests in comparison with most other oyster-growing areas of the world. Nevertheless there are several, and growers should be able to recognize and to deal with them. All of them are without backbones and range from one-celled protozoa to quite highly developed forms like oyster drills.

Parasitic Copepod

The parasitic copepod is a crustacean distantly related to crabs and shrimps. It is a small bright-red organism with a maximum length of 3 mm. It occurs in the small intestine of molluscs such as oysters and mussels usually close to the anal opening and there may be five or six in a single oyster. They are not harmful if eaten and while they may cause both mortality and reduced condition this has not so far been a problem in British Columbia. Infection in raft-cultured oysters is less than in those cultured on the bottom.

Crabs

As a general rule crabs have not been a serious predator in British Columbia although few beds escape some damage, particularly to small seed.

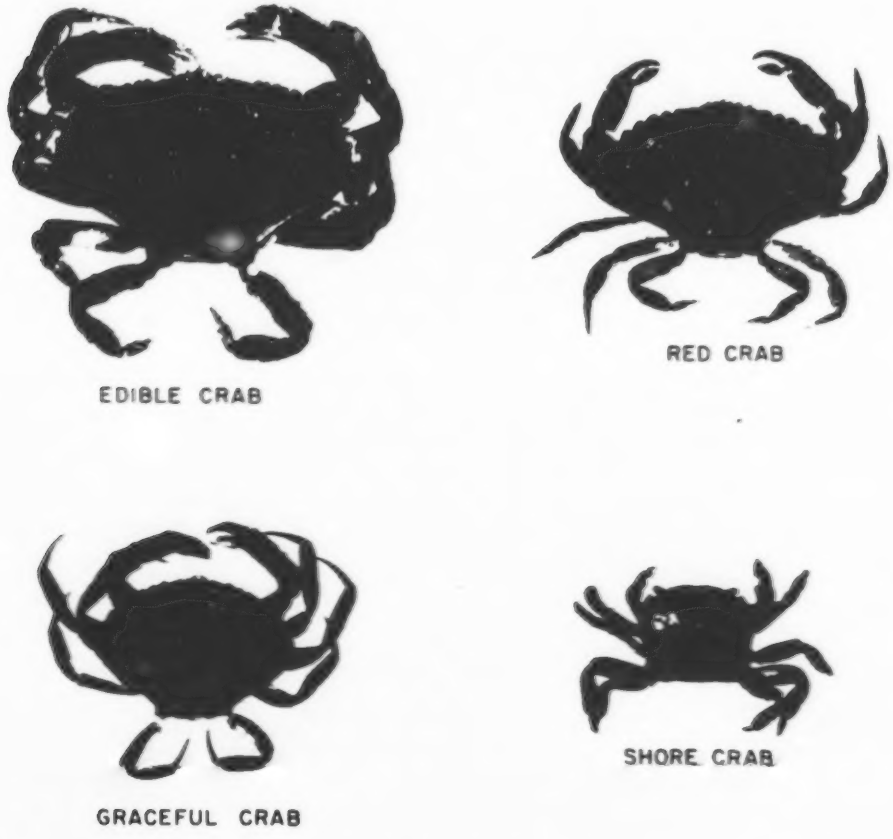

FIG. XXIV. Four species of crab commonly found on oyster-beds: Edible or Dungeness crab (*Cancer magister*), X 0.25; Red or Rock crab (*Cancer productus*), X 0.25; Graceful crab (*Cancer gracillis*), X 0.3; Shore crab, of which there are two species (*Hemigrapsus*), X 0.5.

The oyster shells are cracked by the strong pincer claws of the crabs, four species of which may occur on oyster beds. If a problem arises as evidenced by dead oysters with broken shell edges, simple traps made of wood laths may help eradicate the crabs.

Barnacles

Common shore barnacles such as the acorn barnacle (*Balanus glandula*) and the conical barnacle (*Chthamalus dalli*) have very definite zones (high intertidal area) where they settle. If oysters are held below this zone there will be little barnacle settlement on them but if placed in the barnacle zone, heavy settlement, particularly from the larger acorn barnacle, may be expected. This species settles most extensively within a week or 10 days before or after April 1 in most areas of the Strait of Georgia, although there may be some settlement throughout most of the summer. Settlement of barnacles causes relatively little harm to segments of the oyster industry utilizing bottom culture methods, except increasing the weight of the oyster and causing a nuisance to shuckers. It can cause serious fouling problems, however, to culturists who are rearing shellstock by off-bottom methods, and it is recommended that growing procedures should be altered accordingly to reduce the problem.

Oyster Drills

Oyster drills are among the most damaging of the pests found on oyster-beds. They are univalve snails which have an extensible toothed rasp with which they drill in a clam or oyster shell a neat round hole through which they can tear away the meat. There are two species of drills, a Japanese species and a native or local one, the latter doing relatively little damage to oysters. The best method of control is by carefully cleansing the ground when harvesting, particularly of dead shells and debris. Only oysters larger than about 2 inches in length should be planted on drill infested ground, for drills have difficulty with the thicker shells of oysters of this size.

Starfish

Starfish are serious predators on many British Columbia oyster-beds, particularly on those which include or are near rocks. Starfish are able to open a mollusc partly by pressure and partly by the ability to insert a protrusible stomach through a very narrow aperture. There are a number of starfish species but only about four of them are serious predators.

Control is by direct picking and removal or by destroying them with application of a teaspoon of quicklime or carbide to the body which is disintegrated by corrosive action of the chemical.

Flatworm

This is a small wafer-thin worm about three-quarters of an inch long and one-half inch wide able to drill small holes in oyster seed up to about three-quarters of an inch in diameter. In some years it may be abundant enough to cause serious damage to small seed but this does not happen frequently. Control may be exercised by dipping seed in fresh water for an hour or so.

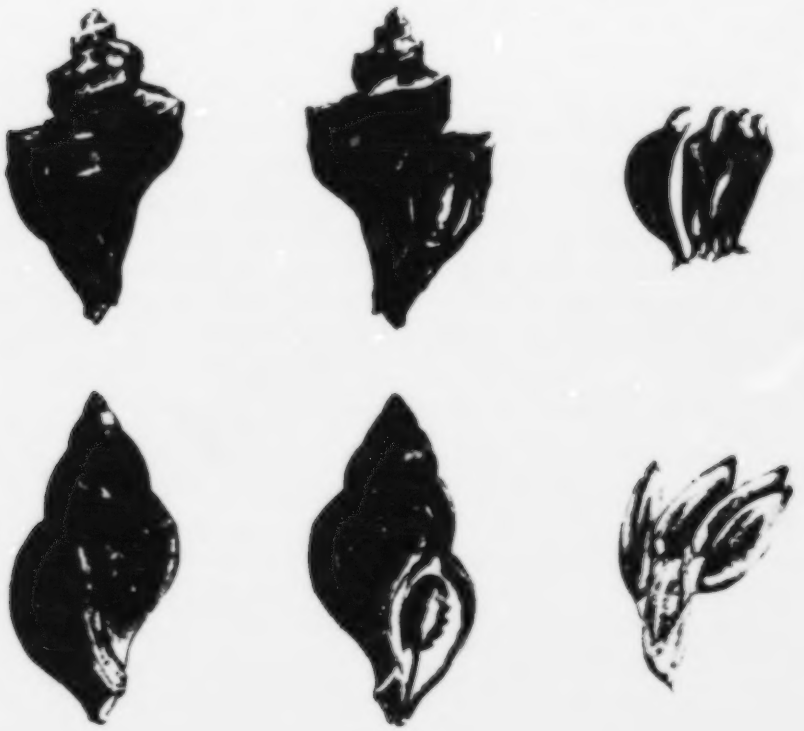

FIG. XXV. Comparison of the shells (X 1.3) and egg capsules (X 3.6) of the Japanese oyster drill (top) with those of the native drill (bottom).

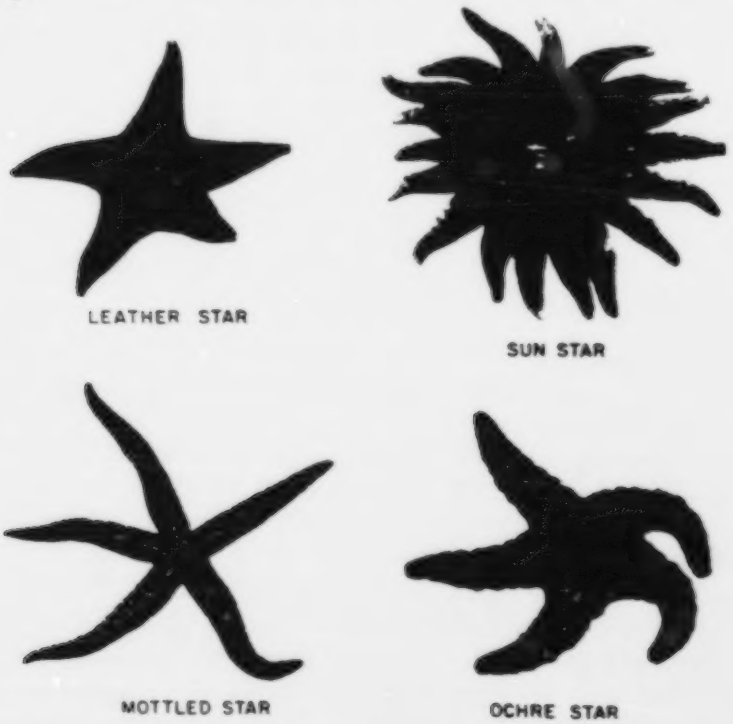

FIG. XXVI. The four common sea stars found on or near oyster-beds: Leather star (*Dermasterias imbricata*), X 0.2; Sun star (*Pycnopodia helianthoides*), X 0.1; Mottled star (*Evasterias troschellii*), X 0.1; Ochre star (*Pisaster ochraceus*), X 0.2.

POLLUTION

This is probably the most serious of the problems of the shellfish industry today, not only in British Columbia, but throughout the world. In the Canadian Maritime provinces of Nova Scotia, New Brunswick, and Prince Edward Island, there are about 150 shellfish-growing areas which are unproductive because of pollution. British Columbia is relatively newly settled, with a small population and it would be expected there would be few, if any, shellfish pollution problems as yet. However, sewage pollution has already closed or limited a significant proportion of oyster-producing ground, and industrial pollution is a problem in at least one oystering area.

Classification of Shellfish-growing Areas

Shellfish-growing areas are classified in three ways, partly on the basis of a bacteriological study of growing waters and partly on the basis of a sanitary survey, where a study is made of such factors as population density and distribution, sewage-disposal systems, river discharge points and flow rates, geology, distribution of docks and boats, hydrography, etc. The following sections are taken from *The Regulations for Sanitary Control of the Shellfish Industry in British Columbia:*

(1) *Approved areas*—Shellfish may be taken for market purposes from approved areas at any time provided that any rules or regulations concerning conservation or the regulations concerning relaying are not violated.

(2) *Restricted areas*—Shellfish shall not be taken from any restricted area, except under written permission of the Minister of Fisheries and only under any specific condition imposed by the Minister.

(3) *Closed areas*—Shellfish shall not be taken from closed areas except for the purpose of depletion, and then only under written permission and strict control of the Minister. Oyster leases shall not be granted in closed areas.

Paralytic Shellfish Poisoning (P.S.P.)

Paralytic shellfish poisoning or "red tide" as it has become more commonly known, is caused by a microscopic dinaflagellate plankton organism which produces a virulent poison in its body. However, British Columbia waters contain a number of one-celled organisms that may cause coloured water but which are not toxic. When filter feeders such as oysters and clams feed on this organism, the toxin from it is released in the digestive process and accumulated and stored in the body of the shellfish.

Historically, P.S.P. has been a summer phenomenon, occuring when light, temperature, salinity, and nutrients are present in the right combinations so that rapid multiplication occurs. These outbreaks of shellfish poisoning are located for the most part in the Queen Charlotte area and the west coast of Vancouver Island. Occurrence of P.S.P. in the Strait of Georgia, where the majority of oyster production takes place is relatively rare, but, an extensive monitoring program is constantly conducted to ensure that shellfish are safe for consumption.

MARKETING

The Pacific oyster, grown in British Columbia, is marketed for the most part in the fresh-shucked state in a number of ways. These are—

(*a*) direct to the consumer;

(*b*) to retailers;

(*c*) to wholesale fish dealers;

(*d*) to processors.

The method of marketing is generally related to two factors—

(*a*) the volume capability of the grower; and

(*b*) the size of oyster being marketed.

A grower with a large volume of oysters might find it more convenient to market direct to wholesale fish dealers, while small producers tend to develop their own markets to retailers such as restaurants and supermarkets.

The size of oysters also dictates to the method of marketing with large oysters (soup grade) being sold in bulk (4-gallon containers) to processors, small oysters (table grade) are packaged in gallon, pint, or half-pint containers for distribution direct to the consumer, retailers, and to some extent, wholesalers.

Oysters also are marketed in the shell for the half-shell luxury trade as well as in a processed form. Processed oysters include smoked, pickled, canned, whole, soups, stews, and frozen. British Columbia's present production of processed oysters amounts to only a small percentage of its total production.

ADMINISTRATION

Oyster Leases/Licences

All foreshore in British Columbia is held by the Crown in the right of the Province, except that situated in national harbours such as Victoria, Esquimalt, Nanaimo, Alberni, Burrard Inlet, and New Westminster. British Columbia Crown lands are administered by the Department of Environment, Lands Branch. All inquiries relating to leasing or licensing of foreshore should be directed to the Superintendent of Lands, Parliament Buildings, Victoria, B.C.

The British Columbia Government has, for many years, adhered to the policy of not disposing outright of any foreshore. The Government will, however, lease/licence foreshore for various purposes for varying lengths of time as provided for in the *Land Act*. One of the purposes for which the Government will lease/licence foreshore is shellfish culture, including the growing of clams and oysters.

Leases/Licences of Crown Lands

Leases/licences containing such covenants and conditions as may be deemed advisable, of unoccupied and unreserved Crown lands, surveyed or unsurveyed, may be granted for the purpose of shellfish culture.

"lease" means the disposition of Crown land for the purpose of shellfish culture, subject to such terms, conditions, and reser-

vations deemed necessary by the Ministers of Environment and Recreation and Travel Industry, but not to exceed a term of 20 years;

"licence" means a licence of occupation to occupy and use temporarily Crown land for shellfish culture, subject to such terms, conditions, and reservations deemed necessary by the Ministers of Environment and Recreation and Travel Industry, but not exceeding a term of 10 years.

The area leasable will not exceed 640 acres in extent, except that by Order in Council a greater area may be granted where the land required is shown to be actually required for bona fide industrial purposes.

Mode of Acquiring Leases/Licences

Unsurveyed lands—Any person desirous of procuring a lease of unsurveyed land must first stake the land. He will place securely in the ground or in a stone mound at one corner or angle a legal post—a post at least 4 inches square and standing at least 4 feet above the ground—and upon this inscribe his name and the angle or corner it marks, thus: "A.B.'s N.E. corner" or as the case may be; also a written or printed notice is to be posted thereon, giving a description in detail of the length and direction of the boundary-lines of the land to be applied for, date of location, and notice of his intention to apply for permission to lease the said land. The land may be staked or located by an agent.

After the land is so staked and marked, the applicant will within 30 days after the location being made—an additional day is allowed for every 10 miles or fraction thereof over 10 miles which the land is distant from the office of the Land Commissioner—post a notice in writing in the office of the Land Commissioner of the district in which the land is situated of his intention to apply for permission to lease. Such notice will be as in Form 15 of the *Land Act,* copies of which can be obtained from the Commissioner or from the Department of Environment.

This notice is to give a description as accurately as possible of the land the applicant desires to lease, especially with reference to the nearest known point or to some creek, river, stream, or other water; the name of the land district in which it is located; boundaries and extent of the land; date of location, name, residence, and occupation of applicant.

The applicant will then make a statutory declaration, Form 14 of the *Land Act,* copies of which can be obtained from the Land Commissioner or from the Department of Environment, and deposit the same with the Commissioner at the time of posting the notice of his intention to apply for a lease. This declaration may be made by an agent and it gives the name, address, and occupation of the applicant, or that of his agent if made by an agent; a statement of intention to apply for the lease; date and particulars of staking and of posting the necessary notices and inscriptions on the post; the declaration to be made before a Commissioner, Justice of the Peace, Notary Public, or person duly authorized.

Within 30 days after staking the land—one additional day is allowed for every additional 10 miles or fraction thereof over 10 miles which the land is distant from the office of the Land Commissioner—the applicant shall commence and continue to publish the notices (Form 15) at his own expense, and shall publish the same once each week for four consecutive weeks in *The British Columbia Gazette* and in a local newspaper published in the land recording district in which the land is situated, or in absence of such a local newspaper, in a paper published nearest to the district.

Within two months from the date of the first publication of the notice in *The British Columbia Gazette,* application will be made in duplicate to the Commissioner for such lease. The application is to be made upon the printed form supplied and conform to all the requirements of the said form; and the applicant shall also file a statutory declaration in duplicate of the publication of the notice.

The Commissioner will then forward one copy of the application and of the declaration, together with his report thereon, to the Department of Environment at Victoria.

Surveyed lands—No staking is required, nor is advertisement necessary, in applications to lease surveyed lands. The applicant makes written application to the Land Commissioner of the district in which the land is situated, in duplicate, giving his name, address, occupation, number, location, acreage of the lot, and the purpose for which it is required.

The Minister may, if there appears to be no valid objection on receiving the application from the Land Commissioner, give notice to the applicant that a lease will be issued as desired. In the event of the land being unsurveyed, it is provided that the applicant must have the land surveyed in a legal manner within six months from the date of such notification. All surveys of lands so leased shall conform to the regular system of surveys in all respects, except that the lengths of the boundaries thereof shall be to the satisfaction of the Minister of Environment and in accordance with regulations made by the Surveyor-General.

The Commissioner of each land district will keep a register of all applications, to be indexed as to names of applicants and localities; every application to be numbered and such number registered.

Upon receipt of an application by the Superintendent of Lands to lease foreshore for shellfish cultivation, the application is first cleared by the Lands Branch of the Department of Environment by the Survey Branch. If sufficient information is not available within the Branch the application is reported on by an officer of the Department of Environment. Staff from the Marine Resources Branch, Department of Recreation and Travel Industry examine all foreshore applied for, for oyster culture and prepares an assessment on the suitability of the area for oyster-culture purposes. If the area applied for is unsurveyed and has been cleared by the Marine Resources Branch and the Department of the Environment, the report being favourable and no protests having been filed, the application is then approved, subject to survey, and the applicant is advised to have his surveyor get in touch with the Surveyor-General for necessary instructions. When the survey is completed

and the applicant's surveyor has reported to the Surveyor-General, the survey is gazetted. After the survey has been gazetted and no valid reasons arise to the contrary, the applicant is advised as to the amount of rental payable which is based on its production potential, and upon receipt of payment, a lease is prepared for execution.

COSTS

Rental Fees—

1. Minimum annual rental for any lease area, $50.

2. Minimum annual rental of $1 per acre for new leases for the first four-year period unless the bed is established with wild oysters, then item 3 can apply.

3. After the first four-year period and at the five-year review period of other leases rentals used may be

(*a*) up to $5 per acre for waste areas;

(*b*) up to $15 per acre for productive areas;

(*c*) areas of fill or of commercial use may be appraised on the basis of market value at 8 per cent (example—shucking-shed and purposes incidental thereto).

4. Exceptionally good lease areas may have rentals up to $30 per acre for productive areas. Substantiation for such rentals must be detailed and complete.

5. Leases which are in contaminated waters by Departmental decision may have the normal rental reduced by 50 per cent for so long as the condemned classification remains.

Taxes—Assessed value for taxation purposes, on areas leased for oyster culture, are determined on the basis of the area's suitability (potential productivity). Regional mill rates are applied to the assessed value to determine the tax payable. Present tax rates on leased-ground ranges from $5 to $10 per acre per year.

The lease is then forwarded to the applicant for signature of the several copies and is then returned to the Department of Environment for final execution by the Deputy Minister of Environment.

It will be noted that in some cases considerable time is required for final completion of an application to lease foreshore. This is particularly true when foreshore requires survey, as in many cases the survey can be made only at extreme low tide and as low tides occur in daylight only in summertime it is difficult to have the survey and biologist's examination made during winter. This delay of surveys, does not occur if the land being applied for has already been surveyed.

Immediately upon receipt of issuance of a lease by the Department of Environment for oyster- or clam-culture purposes, the lessor is required to register the holding with the Marine Resources Branch. Forms for this purpose may be obtained from the Marine Resources Branch, Parliament Buildings, Victoria, B.C. There is no fee in connection with this registration.

PROTECTION

THEFT (Excerpts from the *Criminal Code* of Canada. Offences Against Rights of Property.)

PART VII, SECTION 283

283. (1) Every one commits theft who fraudulently and without colour of right takes, or fraudulently and without colour of right converts to his use or to the use of another person, anything whether animate or inanimate, with intent,

(*a*) to deprive, temporarily or absolutely, the owner of it or a person who has special property or interest in it, of the thing or of his property or interest in it,

(*b*) to pledge it or deposit it as security,

(*c*) to part with it under a condition with respect to its return that the person who parts with it may be unable to perform, or

(*d*) to deal with it in such a manner that it cannot be restored in the condition in which it was at the time it was taken or converted.

Oyster bed

284. (1) Where oysters and oyster brood are in oyster beds, layings or fisheries that are the property of any person and are sufficiently marked out or known as the property of that person, he shall be deemed to have a special property or interest in them.

(2) An indictment is sufficient if it describes an oyster bed, laying or fishery by name or in some other way, without stating that it is situated in a particular territorial division. 1953–54, c. 51, s. 270.

PUNISHMENT FOR THEFT

294. Except where otherwise provided by law, every one who commits theft is guilty of an indictable offence and is liable

(*a*) to imprisonment for ten years, where the property stolen is a testamentary instrument or where the value of what is stolen exceeds two hundred dollars, or

(*b*) to imprisonment for two years, where the value of what is stolen does not exceed two hundred dollars. 1953–54, c. 51, s. 280; 1972, c. 13, s. 23.

PERFORMANCE

Leases/licences are reviewed every five years to determine whether or not "beneficial use" is being demonstrated, such as minimum level of production and (or) properly operated for oyster culture. The latter provision considers that one oyster-grower might be properly operating his lease, and because of lack of proper operation by a leaseholder on adjacent ground, the work of the former may be to a large extent nullified.

Regulations Respecting the Culture and Harvesting of Shellfish

(Regulations Under the Fisheries Act of British Columbia)

Interpretation

7. For the purpose of these regulations

"approved area" means a shellfish area where, in the opinion of the Minister and the Minister of National Health and Welfare, shellfish are safe for direct consumption;

"contaminated area" means a shellfish area that has been declared to be contaminated pursuant to the Regulations Respecting the Sanitary Control of Shellfish Fisheries;

"culture" means the rearing, improvement, development, and production of shellfish;

"Crown land" means such ungranted Crown or public land or Crown domain as is within the Province and belonging to Her Majesty in right of the Province, and whether or not any waters flow over or cover the same, and includes any right, title, or interest therein of the Crown;

"depuration" means the process of removing micro-organisms that may be dangerous to humans from live shellfish in a controlled environment;

"lease" means the disposition of Crown land for the purpose of shellfish culture, subject to such terms, conditions, and reservations deemed necessary by the Minister of Environment, Forests and Recreation and Travel Industry, but not to exceed a term of 20 years;

"licence" means a licence of occupation to occupy and use Crown land for shellfish culture, subject to such terms, conditions, and reservations deemed necessary by the Ministers of Environment, and Recreation and Travel Industry, but not exceeding a term of 10 years;

"Minister" means the Minister of Recreation and Travel Industry;

"relaying" with respect to shellfish, means the moving of shellfish from a contaminated area to an approved area for the purpose of natural biological cleansing;

"safe for direct consumption," with respect to shellfish, means that the shellfish are not unwholesome, as that word is defined in the Fish Inspection Regulations and may be used for food without being subjected to depuration or relaying;

"shellfish" means oysters, clams, mussels, and other bivalve molluscs except scallops;

"shellfish area" means an area in which shellfish are found;

"shellfish management area" means an area set aside under the authority of the *Land Act*, reserved from alienation to protect

the culture of oysters, oyster-seed production, and to preserve the ecological integrity of the area;

"transplanting," with respect to shellfish, means the moving of shellfish from one shellfish area to another shellfish area for any purpose other than natural biological cleansing.

Oysters

8. (1) No person shall, except by special permission of the Minister of Recreation and Travel Industry for the Province of British Columbia,

(*a*) plant or introduce; or

(*b*) use or cause to be used any equipment to plant or introduce into an oyster-bed or any waters of the Province oysters, oyster-seed, oyster-cultch, or oyster-shells from outside the Province.

(2) No person shall, except by special permission of the Minister of Recreation and Travel Industry for the Province of British Columbia, transport or cause to be transported from any area described below any oysters, oyster-seed, oyster-cultch, oyster-shell, marine organisms adversely affecting oysters, or any tools, boats, scows, or other material used in connection with oyster culture or harvesting.

(*a*) *Boundary Bay Area,* which comprises all tidelands in Boundary Bay and Mud Bay inside (north) of the International Boundary Line between Point Roberts and the Mainland (Blaine).

(*b*) *Crofton Area,* which comprises all tidelands surrounding the Shoal Islands between the Osborne Bay Lighthouse and the Bare Point Lighthouse at Chemainus.

(*c*) *Thetis Island Area,* which comprises

(i) all tidelands in North Cove inside (southeast) of a line drawn between Fraser Point and Pilkey Point;

(ii) all tidelands surrounding Hudson Island and Scott Island; and

(iii) all tidelands in Telegraph and Preedy Harbours inside (east) of a line drawn between Crescent Point and Active Point on Thetis Island.

(*d*) *Ladysmith Harbour Area,* which comprises all tidelands inside (west) of a line drawn between Sharpe Point and the white navigation beacon on Holland Bank.

(*e*) *Henry Bay Area,* which comprises all tidelands in Henry Bay inside (east) of a line drawn 169° true from Longbeak Point, the northerly tip of Denman Island.

(*f*) *Comox Harbour Area,* which comprises all tidelands inside (northeasterly) of a line drawn from Goose Spit to the outer end of the Government dock in Comox Harbour.

(*g*) *Pendrell Sound Area,* which comprises all the waters and tidelands of Pendrell Sound inside (northerly) of a straight line joining Durham Point and Walter Point.

(3) No person shall market oysters taken from a "contaminated area" as defined in Schedule J of the British Columbia Fishery Regulations made by Order in Council P.C. 1954-1910, as amended, until such oysters have been held on a registered lease or licensed area not in a contaminated area for a period of two weeks, or a time specified by the Minister of Fisheries, or in a licensed depuration plant immediately prior to marketing.

Harvesting of Oysters From Vacant Crown Foreshore

9. (1) (*a*) No person shall take or have in his possession oysters for commercial purposes other than from a registered oyster lease or a registered oyster licensed area, except as authorized by a permit issued to him by the Minister. A permittee under this subsection may only dispose of the oysters so taken to a registered oyster-lease holder.

(*b*) For the purpose of these regulations, any person taking or having in his possession, from Crown lands, more than 25 oysters in the shell or more than one quart of shucked oysters, in any one day, shall be deemed to have taken the oysters for commercial purposes.

(2) The Minister may issue permits for the purpose of this section, but each permit so issued

(*a*) shall require application of a form supplied by the Minister, 30 days prior to the applied permit date;

(*b*) shall cover a specific operation over a specific area of Crown foreshore and shall be for a period not to exceed 30 days;

(*c*) shall exclude all dispositions made under the provisions of the *Land Act* either prior to or subsequent to the issuance of a permit;

(*d*) shall be under such terms and conditions as the Minister may prescribe;

(*e*) shall be subject to the payment of a prescribed fee of $10 for each area from which oysters are to be taken;

(*f*) shall be subject to the riparian rights of upland owners fronting on the Crown foreshore covered by the permit;

(*g*) shall require the permittee to leave the foreshore in a clean, safe, and sanitary condition to the satisfaction of the Minister;

(*h*) shall require the permittee to save the Crown harmless from any claims which may be made against the Province of British Columbia by reason of anything done, or left undone, by the permittee, and;

(*i*) shall be subject to the Regulations Respecting the Sanitary Control of the Shellfish Fisheries, P.C. 1972-2406, *Fisheries Act,* R.S. 119, s. 1.

(3) Every person who is granted a permit to harvest oysters under this section shall render a statement, on a form supplied by the Minister, within 10 days of the expiry date of such permit. This statement shall record the production and disposition of shellstock under the permit and shall be submitted to the Marine Resources Branch.

(4) Every person who harvests oysters under a permit granted under this section shall jointly with the statement in subsection (5) above pay to the Minister of Finance a royalty equal to $5 per ton on all oysters (shell-stock) taken.

(5) Any person who violates any provision of this section is liable, on summary conviction, to a fine of not less than $25 and not more than $1,000.

(6) Under this section, permits granted to take oysters commercially from foreshore fronting Indian reserves must require written upland owners consent. Nothing in the foregoing shall prevent, restrict, or control the harvesting of oysters in the above-mentioned areas by an Indian, as defined in the *Indian Act* for personal food purposes.

(7) Pursuant to this section, a permit issued for the harvesting of oysters from contaminated vacant Crown foreshore must comply with the Sanitary Control of Shellfish Fisheries Regulations P.C. 1972-2406.

(8) Pursuant to this section, all harvesters must hold a valid personal commercial fishing licence.

Shellfish Culture

10. (1) Every person who engages in the business of cultivating, growing, or harvesting oysters, claims, or other molluscs from licensed or leased foreshore or water lot shall registered with the Marine Resources Branch of the Department of Recreation and Travel Industry, giving the name and address of the grower, species grown, the location, legal description, and acreage in each lot.

(2) Every registered grower shall re-register annually with the Marine Resources Branch immediately following the 31st day of March.

(3) Every registered grower shall notify the Marine Resources Branch of any change in status immediately such change takes place.

(4) Every registered grower of shellfish shall make a return to the Marine Resources Branch not later than March 31 in each year, on a form supplied by the Department, setting out the quantity of shellfish harvested, the species, and the area from which they were harvested.

Shellfish Management Areas

11. The area known as Pendrell Sound, Redonda Island, New Westminster District, lying north of a straight line between Walter Point and Durham Point, is reserved from alienation to protect the culture of oysters, oyster-seed production, and to preserve the ecological integrity of the area.

(1) Pursuant to this section, all activities defined as oyster culture conducted in the area known as Pendrell Sound, must have the special permission of the Minister;

(2) Pursuant to this section, the part of Pendrell Sound that lies north of a line joining position 50°15′12″N., 124°43′50″W., and position 50°14′47″N., 124°43′21″W., is subject to Part II of Schedule C of the Boating Restriction Regulations, *Canada Shipping Act*, P.C. 1973-770.

Other Government Departments

Production Statistics

The oyster-grower is required to provide production statistics to the Fisheries and Marine Services on a monthly basis as indicated on the form shown below:

Oyster Production Report Form

Page of Pages

Oyster Production Report for the Month of ..... 19....

Company..... Grower-Packer No. .....

Address..... Wholesale No. .....

Total shucked production for month ..... U.S. gal. % Wild oysters .....

MARKETINGS DURING MONTH

Number of Units										Total Value	
8's	12's	16's	32's	128's	Bulk	Shell			Tons	Wholesale	Retail

Interprovincial or International Trade in Oysters

If the grower is involved in interprovincial or international trade in oysters, the Inspection Branch of the Fisheries and Marine Service and the Public Health Engineering Division of the Federal Department of Health and Welfare may be concerned. The latter department is responsible for management of the reciprocal agreement between the United States and Canada regarding certification of shellfish. In 1948, Canada and the United States agreed to accept each other's certification of shellfish plants and growing areas, and each country provides the other with a list of acceptable producers. Certification is based largely on the *United States Public Health Service Manual of Recommended Practice for the Sanitary Control of the Shellfish Industry*. Canada has a voice in the formulation of this manual through participation in Shellfish Sanitation Workshops and other conferences. Reciprocal inspection at a Federal level is provided for, and there are joint research projects from time to time; the results of these form, in part, the basis for the U.S. Manual and revisions of it.

Simply, a British Columbia oyster-grower can ship oysters to the United States provided he is on the reciprocal agreement certification list; the basis for his being on this list is his degree of compliance with the British Columbia regulations for shellfish sanitation. The Food and Drug Directorate of the Federal Department of Health and Welfare also examines from time to time the sanitary quality of oysters in samples taken from retailers' stocks.

ADDITIONAL INFORMATION ABOUT OYSTER CULTURE

This handbook presents only a brief sketch of oyster-farming in British Columbia. Particular problems related to individual oyster-growers or prospective growers have not been fully outlined in this publication. Further information on oyster culture can be obtained from the Marine Resources Branch, the Pacific Biological Station, the B.C. Oyster Growers Association, or the appropriate Government agency concerned.

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